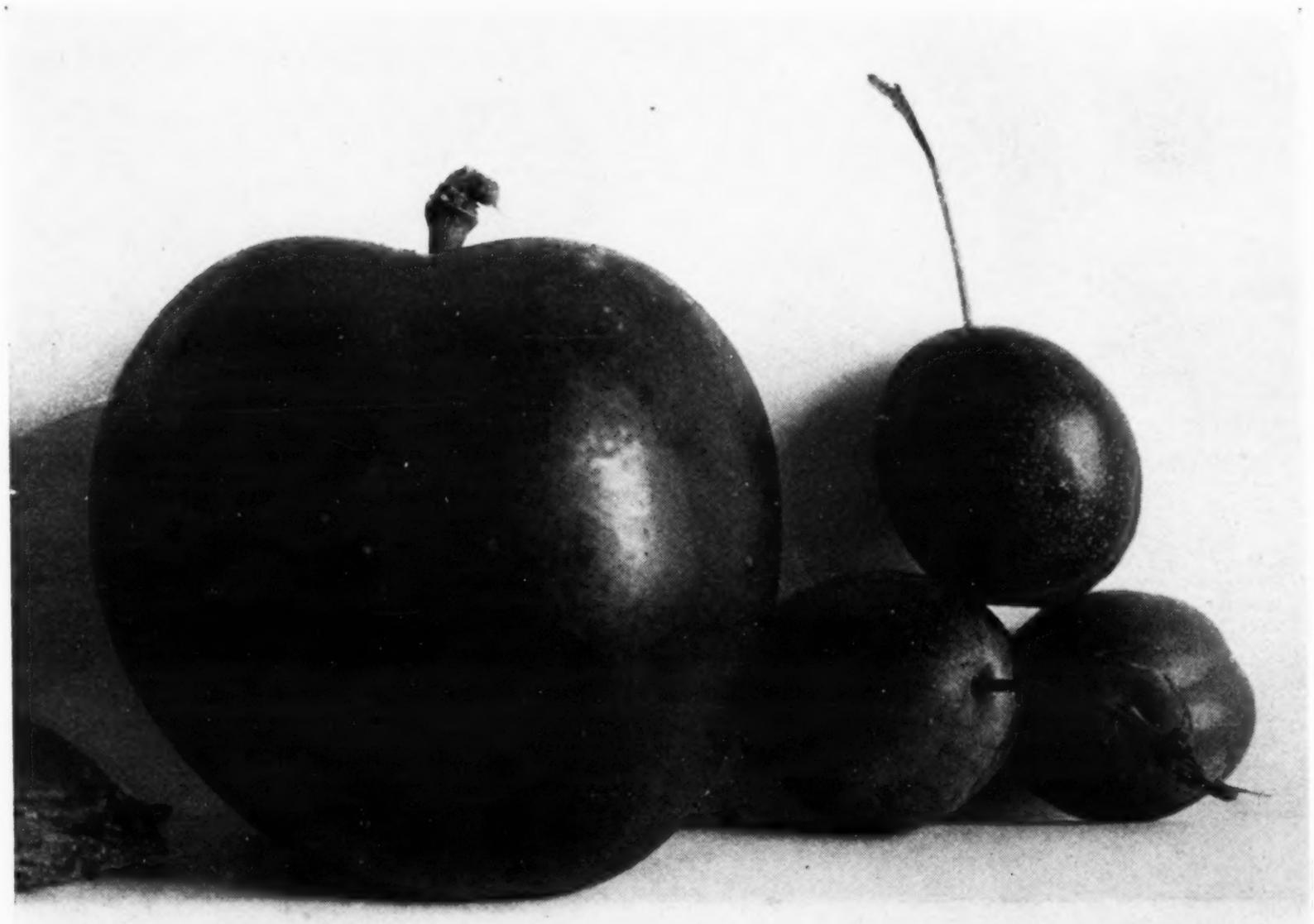
AUG 20 1928

ZOOLOGICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics



A HYBRID PLUM AND ONE OF ITS ANCESTORS

(See "Burbank's Results with Plums," p. 359)

Chromosome Aberrations in Animal Improvement

"Siamese Twin" Soybeans **Race Characters Endure**

A Mutation Resembling Mosaic Disease

AUGUST, 1928 Vol. 19, No. 8

The American Genetic Association

President, David Fairchild — Vice-President, W. E. Castle — Secretary, C. E. Leighty
Treasurer, Mrs. G. W. Sincell

EDITORIAL BOARD

M. DEMEREC — R. R. GRAVES — L. C. DUNN
H. J. MULLER — GEORGE M. DARROW — PAUL POPENOE

Members of the Council are ex-officio members of the Editorial Board

Managing Editor: ROBERT C. COOK

COUNCIL

W. E. CASTLE, Professor of Zoology, Harvard University, and Research Associate of the Carnegie Institution of Washington.
LEON J. COLE, Professor of Genetics, University of Wisconsin.
G. N. COLLINS, Botanist, U. S. Department of Agriculture, Washington, D. C.
O. F. COOK, Bionomist in Charge of Breeding Investigations, U. S. Department of Agriculture.
DAVID FAIRCHILD, Agricultural Explorer, U. S. Department of Agriculture.
HARRY V. HARLAN, Senior Agronomist in Charge of Barley Investigations, U. S. Department of Agriculture.
C. E. LEIGHTY, Agronomist in Charge of Eastern Wheat Investigations, U. S. Department of Agriculture.
VERNON KELLOGG, Chairman, Division of Educational Relations, National Research Council, Washington, D. C.
J. H. KEMPTON, Bureau of Plant Industry, U. S. Department of Agriculture.
E. W. SHEETS, Chief of Animal Husbandry Division, U. S. Department of Agriculture.
FREDERICK ADAMS WOODS, Lecturer on Biology, Massachusetts Institute of Technology.
SEWALL WRIGHT, Associate Professor of Zoology, University of Chicago.

ADVISORY COMMITTEE

W. S. ANDERSON, Genetics Department, University of Kentucky, Lexington, Kentucky.
E. B. BABCOCK, Genetics Department, University of California, Berkeley, California.
E. A. BESSEY, Professor of Botany, Michigan State College, East Lansing, Michigan.
A. F. BLAKESLEE, Plant Genetist, Carnegie Institution, Cold Spring Harbor, New York.
J. K. BREITENBECHER, McGill University, Montreal, Canada.
W. E. BRYAN, Professor of Plant Breeding, University of Arizona, Tucson, Arizona.
C. B. DAVENPORT, Director, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, L. I., New York.
J. A. DETLEFSEN, Professor of Genetics, Wistar Institute, Philadelphia, Pennsylvania.
RUSSELL W. DUCK, Professor of Animal Husbandry, Syracuse University, Syracuse, New York.
E. M. EAST, Professor of Plant Genetics, Bussey Inst. of Applied Biology, Boston, Mass.
R. A. EMERSON, Professor of Plant Breeding, Cornell University, Ithaca, New York.
C. P. GILLETTE, President, The Genetic Foundation, Fort Collins, Colorado.
C. M. GOETHE, Sacramento, California.
FREDERICK O. GROVER, Professor of Botany, Oberlin College, Oberlin, Ohio.
ROBERT T. HANCE, Rockefeller Foundation for Medical Research, New York City.
HARRISON R. HUNT, Professor of Biology, Michigan Agricultural College, East Lansing, Mich.
R. E. HUNT, Professor of Animal Husbandry, Virginia Polytechnic Institute, Blacksburg, Virginia.
H. S. JENNINGS, Professor of Zoology, Johns Hopkins University, Baltimore, Maryland.
D. F. JONES, Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.
F. B. LINFIELD, Director, Montana Experiment Station, Bozeman, Montana.
WM. A. LIPPINCOTT, Professor of Poultry Husbandry, University of California, Berkeley, Cal.
C. C. LITTLE, President, University of Michigan, Ann Arbor, Michigan.
JAY L. LUSH, Animal Husbandman, Texas Agricultural Experiment Station, College Station, Texas.
H. H. NEWMAN, Professor of Zoology, University of Chicago, Chicago, Ill.
T. S. PALMER, Expert in Game Conservation, U. S. Dept. of Agriculture, Washington, D. C.
JOHN H. PARKER, Professor of Agronomy, Kansas State College, Manhattan, Kansas.
MRS. CHARLES C. RUMSEY, Wheatley Hills, Westbury, Long Island.
JOHN M. SCOTT, Vice Director, Florida Agricultural Experiment Station, Gainesville, Florida.
JOHN W. SCOTT, Professor of Zoology, University of Wyoming, Laramie, Wyoming.
A. D. SHAMEL, Pomologist, U. S. Department of Agriculture, Riverside, California.
GEORGE H. SHULL, Professor of Biology, Princeton University, Princeton, New Jersey.
W. W. SMITH, Professor of Animal Husbandry, Purdue University, Lafayette, Indiana.
CHARLES R. STOCKARD, Professor of Anatomy, Cornell University, New York City.
A. B. STOUT, Director of Laboratories, New York Botanical Gardens, New York City.
W. T. SWINGLE, Plant Physiologist in Charge of Breeding Investigations, U. S. Department of Agriculture, Washington, D. C.
LOU D. SWEET, Seedsman, Denver, Colorado.
W. H. TOMHAVE, American Aberdeen-Angus Breeders' Association, Chicago, Ill.
H. E. WALTER, Professor of Biology, Brown University, Providence, Rhode Island.
H. J. WEBBER, Director, Citrus Experiment Station, Riverside, California.
E. N. WENTWORTH, Armour's Bureau of Agr'l Research and Economics, Chicago, Illinois.
P. W. WHITING, Department of Biology, University of Pittsburgh, Pittsburgh, Pa.

The

Journal of Heredity

VOL. XIX, NO. 8 AUGUST, 1928

CONTENTS

THE "WIRY" TOMATO ..... J. W. and M. M. LESLEY 337
THE UTILIZATION OF CHROMOSOME IN THE IMPROVEMENT OF ANIMAL FORMS ..... CALVIN B. BRIDGES 349
ASEXUAL REPRODUCTION OF COTTON ..... H. E. REA 357
BURBANK'S RESULTS WITH PLUMS ..... D. F. JONES 359
SOYBEAN SEEDS WITH DOUBLE EMBYROS ..... F. V. OWEN 373
THE INHERITANCE OF ANTHRACNOSE RESISTANCE ..... A. S. COLBY 377

REVIEWS AND ABSTRACTS

BEST HONEY LOCUST BEANS: SEVENTY DOLLARS IN PRIZES 344
GENETICS HUMANIZED 345
RACE CHARACTERS OF THE ENGLISH 347
RACE CHARACTERS ENDURE 354
METCALF WILL CASE STILL PENDING 355
MEASURING MENTAL DIFFERENCES 374
SEREBROVSKY AND PETROV'S PAPER NOT A TRANSLATION 376
A LIVESTOCK ENCYCLOPEDIA 382

The JOURNAL OF HEREDITY is published monthly by the

AMERICAN GENETIC ASSOCIATION

At 1918-32 Harford Avenue, Baltimore, Md., and Victor Building, Washington, D. C.

Address communications regarding editorial matters and the business management of the Association to Room 306, Victor Building, Washington, D. C.

Entered as second class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized December 20, 1918. **Contents copyrighted 1928 by the American Genetic Association. Reproduction of articles or parts of articles permitted only upon request, for a proper purpose, and provided due credit is given to the author and to the JOURNAL OF HEREDITY, Washington, D. C.**

$3.50 a Year; 35c. the Copy

Prices of back numbers on application

THE "WIRY" TOMATO LOOKS DISEASED

Frontispiece

This tomato plant is not suffering from disease—it is afflicted with a pair of recessive genes which affect development in such a way that the resulting plant looks as though it were suffering from a severe case of the so-called "shoestring" mosaic disease. It would appear that the "wiry" gene and the mosaic virus produce substances that affect development in a similar way.

THE "WIRY" TOMATO

A Recessive Mutant Form Resembling a Plant Affected with Mosaic Disease*

J. W. and M. M. Lesley
University of California

In the course of breeding experiments at the Citrus Experiment Station, Riverside, California, a tomato plant of a very abnormal kind was observed. From the filiform or wire-like character of foliage this type was named *wiry* (Frontispiece).

The most distinctive characteristics of this type are as follows:

1. The cotyledons are narrow, pale at the margins and often irregularly indented.

2. The leaves are extremely variable in shape, having a tendency towards reduction of the lamina (Figure 1). Some leaves, especially those borne at the lower nodes of the main axis (Figure 2) and of the lateral shoots, approach the normal in shape. Others consist merely of a tapering midrib one centimeter or less in length. Between these extremes many intergrading forms occur, the most common consisting of a narrow, irregularly indented lamina, broadening at the tip into a more normal terminal leaflet. A normal compound leaf is rarely, if ever, to be found. The stems are thin and pliable.

3. Growth is very slow, doubtless on account of the relatively small amount of assimilating tissue. Wiry flowers earlier than normal (non-wiry).

4. The flower (Figure 3) has a tendency towards dialysis. As a rule, neither sepals nor petals are united at their base. The sepals are very variable in shape. They are sometimes narrow and bristle-like, but as a rule are not much reduced in length. Petaloid sepals often occur. The petals are small, narrow and relatively inconspicuous. The anthers are free, almost subulate, and as far as we have observed, contain no pollen. The ovary is partially apocarpus and the component single carpels or pairs of carpels are fused together only at their bases. The styles are separate and are usually much curled. Frequently the ovules are incompletely enclosed by the carpel wall and are exposed to view on the abaxial side (Figure 5).

5. In the field wiry was unfruitful. In the greenhouse it set no fruit when hand pollinated with pollen of normals, but set a few fruits without hand pollination. In size and shape these fruits were somewhat like raspberries (Figure 6) and were entirely seedless.

If the dialysis of floral organs in flowering plants be considered more primitive than coherence, wiry shows a tendency to reversion in flower structure.

The number of chromosomes in the root tips of wiry is 24. This is the normal somatic number for the tomato.

Origin and Genetic Behavior

The leaves of wiry suggest a severe case of the so-called shoestring mosaic disease (Figure 4). Dr. W. F. Bewley, Director of the Experimental and Research Station, Cheshunt, Hertfordshire, England, writes that he has observed a rogue which he believes to be identical with wiry among glasshouse tomato plants. He has not succeeded in transmitting the abnormal condition by juice inoculation and considers that the rogue is due to some genetic cause. At Riverside, neither in the field nor in the greenhouse was there any evidence that this condition was spread by infection to adjacent plants. No wiry plants appeared among many hundreds

*Paper No. 181, University of California, Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, California.

LEAVES AND FLOWERS OF WIRY TOMATO

Figure 1

Shoots of normal tomato (left) and wiry mutant form (right). Leaves of wiry here show extreme reduction. The reason for naming this mutation "wiry" is obvious.

of tomato plants in unrelated cultures growing nearby.

Table 1 shows the number of wiry and normal plants in the parental strains and in F_1, F_2, F_3 and F_4 generations of a cross between Dwarf Aristocrat and 24-1b., a plant selected from the variety Santa Clara Canner. Both the parental types have cut leaves and scarlet fruit. Dwarf Aristocrat has the dwarf habit and relatively small fruits with about 4 loculi: 24-1b. has the standard habit and large fruits with about 12 loculi.

The F_1, F_2 and most of the F_4 progenies were derived from controlled pollination. In uncontrolled pollination at Riverside the amount of natural crossing was measured in two varieties when interplanted. Dwarf Aristocrat, which is short-styled, gave less than 1 per cent of hybrid progeny, whereas Magnus, which has a long protruding style, gave about 5 per cent of hybrids. Excepting 24 and 24-1b., all of the parents shown in Table 1 were short-styled dwarfs in which the probability of natural crossing in uncontrolled pollinations is relatively small.

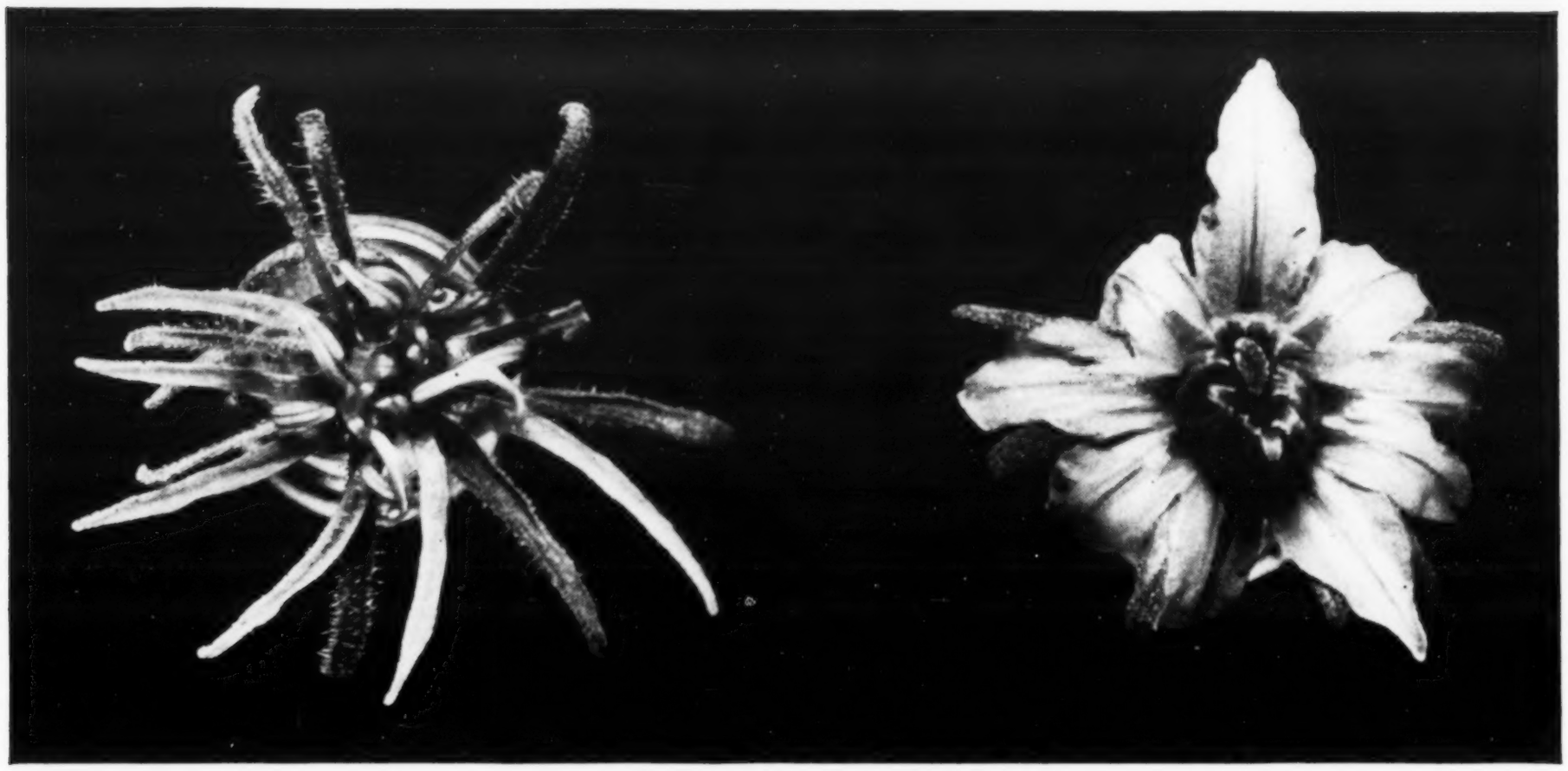
Wiry plants occurred in the F_2, F_3 and F_4 generations from C46-1b., and have not been observed in any of our other cultures. The F_2 generation from C46-1b. consisted of 180 normal and 7 wiry plants, a ratio of 26:1. In the F_3 progeny of C46-1b.-2 the ratio of normal to wiry was similar to that in F_2. In the F_3 from C46-1b.-1 the ratio was 5.9:1. One F_3 and three F_4 progenies consisted of normal plants only. The ratios in

YOUNG WIRY PLANT

Figure 2

Showing variation from nearly normal leaves to extreme "wiry" ones, which are little more than a naked midrib. The first leaves tend to be more nearly normal than the later ones.

the other three F_4 families suggest that the wiry character there behaves as a simple recessive to normal. The deviations from a 3:1 ratio are small (Table 1); the deviation in the largest progeny (from C46-1b.-1-2) is less than one-third and in none of the progenies is as much as twice the standard deviation of simple sampling. On the contrary in the F_2 and two F_3 progenies the deviations from a 3:1 ratio are clearly significant and require explanation. The F_2 was derived from controlled, the two F_3 progenies from uncontrolled pollination. Hence the smaller proportion of wiry plants in F_3 may be merely the result of cross-pollination with normals. There is, however, no other evidence of contamination in these two progenies. The F_4 progenies give no indication of selective elimination at germination. It is possible that both gametes which gave rise to C46-1b.



THE WIRY FLOWER

Figure 3

Flowers of wiry (left) and normal tomato (right) showing narrow petals, free stamens and numerous curled styles of wiry (circular supporting ring is visible in background behind flower of wiry.) Wiry plants at Riverside have always been sterile.

were normal and that wiry occurred as a mutation in somatic tissue early enough so that part of the embryo-sac and pollen mother cells contained the new gene, but it is most improbable that the same somatic mutation should have recurred in two of the F_3 progenies. The fact that the ratios in the F_2 and two F_3 progenies all differed from a 3:1 ratio in the same direction suggests a more probable explanation, namely, that C46-1b. was heterozygous for wiry but contained other genes which are lethal or semi-lethal in combination with the gene for wiry, and that as a result of segregation, C46-1b.-2 received more of the lethal genes present in the F_1 plant than C46-1b-1. However, the ratios of normal to wiry in the F_4 generation indicate that wiry now behaves as a simple recessive. In what follows *w* is used as the symbol for wiry and *W* for its normal allelomorph.

Dr. W. F. Bewley writes as follows of his plants which he believes to be identical with wiry: "Occasionally they bear one or more fruits containing a few fertile seeds. We usually find that these seeds produce normal plants." If the type referred to is identical with wiry, it seems likely that these normal plants resulted from cross-pollination with non-wiry. It is possible that our wiry may be partially fertile under other conditions, but at Riverside no seeds have yet been obtained, although wiry has flowered freely outdoors during two summers and in the greenhouse during three winter seasons. Our stock of wiry could be maintained only by breeding from heterozygous dominants.

No trace of the wiry character was observed in plants known to be heterozygous for the *w* gene. The wiry character is therefore completely recessive. It could readily be eliminated from a heterozygous population by single-plant selection.

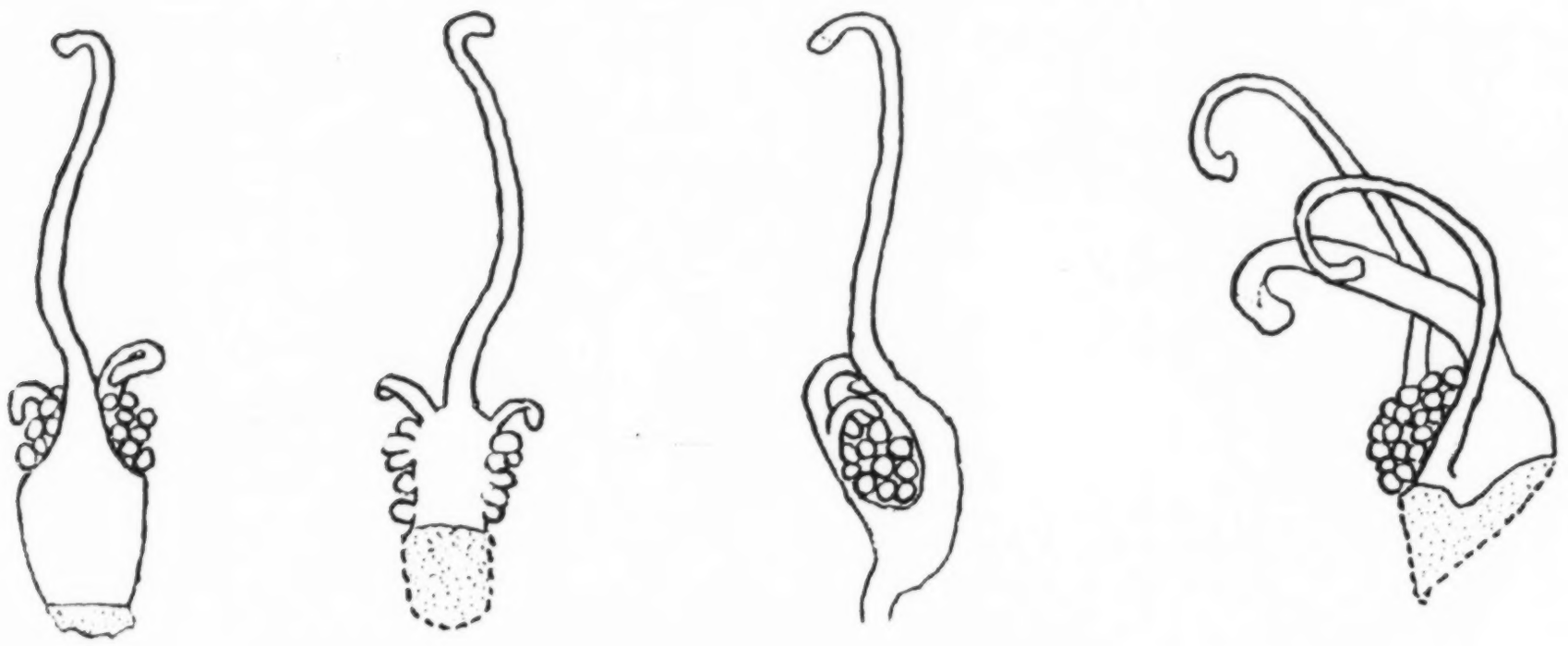
A Similar Mutation in Tobacco

A mutant form of tobacco which in several respects resembles the wiry mutant of tomato has been described by Honing[1] and named *Nicotiana deformis* n. sp. This type originated in Deli tobacco as a result of a single gene mutation. Honing remarks on

NORMAL, MOSAIC AND WIRY TOMATO LEAVES

Figure 4

Leaves of tomato plant affected with shoestring mosaic (left, below), of wiry mutant (right, below), and of healthy plant (above). The mosaic diseases are caused by an infective virus that has a profound effect on the expression of genetic characters. The wiry gene is not infectious.



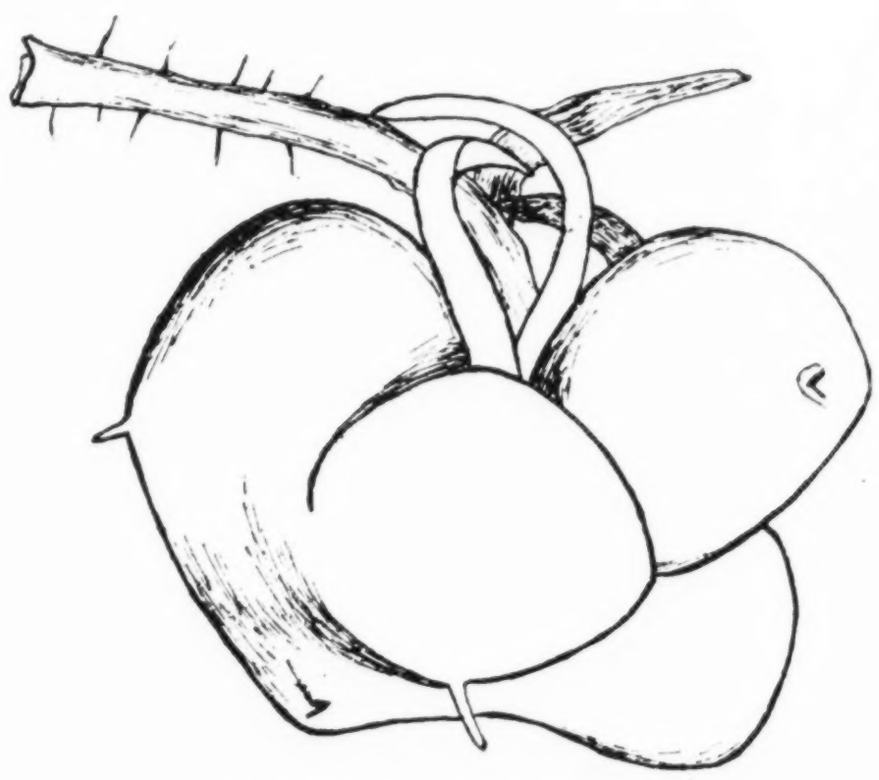
ABNORMAL FLOWER PARTS

Figure 5

Carpels dissected from ovary of wiry, showing apocarpous condition, exposed ovules and twisted styles (×5).

its resemblance to a tobacco plant affected with mosaic disease. In Sumatra *N. deformis* did not flower but in Holland it was fertile and bred true. It is similar to wiry in form of leaves, in slowness of growth and in a tendency to dialysis of the corolla. This is an instance of parallel variation in *Nicotiana* and *Solanum*. On the other hand there are differences between these two mutant forms. In particular, the F_1 between *N. deformis* and normal is intermediate, whereas in tomato, as stated above, wiry is completely recessive. Also the collateral accessory buds and leaf appendages of *N. deformis* were not found in the tomato mutant.

According to Serebrovsky[3] (1927), each recessive mutation can be considered a "little deficiency" which is imperceptible in the heterozygous condition. For the present, it seems best to relate wiry to a gene mutation rather than a deficiency although it may be that, as Serebrovsky's[3] work suggests, the difference between them is of degree rather than of principle. In *Drosophila melanogaster* deficiencies are lethal in the homozygous condition. If wiry is a simple recessive, as it seems to be, it is not lethal when homozygous although it appears to cause sterility. Moreover, in Drosophila a deficiency usually causes a number of small changes in the phenotype. The changes induced by the wiry mutation are numerous but they are relatively great. No chromosomal mutant of tomato with less than the normal chromosome complement is known but comparison of the mutant wiry with the known chromosomal mutants of tomato shows that in wiry the changes induced by a gene mutation are more profound than those induced in any known case



RASPBERRY-LIKE FRUIT

Figure 6

A mature fruit of wiry with remains of styles (×2).

by the addition of a whole extra chromosome to the normal complement. Our data indicate that wiry is not completely linked with dwarf.

Although the malformation of the leaves in a plant affected with the shoestring type of mosaic is often restricted to part of the plant and is not so general as in the wiry mutant, the similarity of the symptoms is so remarkable that one is tempted to seek some similarity of cause. It is conceivable that a similar causal substance is generated in both cases but, as wiry is not of an infectious nature, this substance is probably distinct from the infective principle of mosaic disease. Recently Kraybill and Eckerson [2] have succeeded in separating the juice of tomatoes affected with mosaic by means of glass and collodion filters into two fractions. One fraction contained the infectious principle and caused mottling symptoms after inoculation, the other caused fern-leaf symptoms which somewhat resemble those of shoestring mosaic but apparently it was non-infectious. This discovery seems to add weight to the suggestion that the wiry character is due to the action of a non-infectious toxic substance similar to that causing fern-leaf symptoms.

Summary

In the F_2 generation from a cross between two tomato varieties, among 187 plants 7 had characteristics suggesting severe mosaic-disease symptoms of the shoestring or tendril type. Because of the appearance of the

TABLE I—Results of Wiry Tomato Crosses

Parentage	Generation of progeny	Pollination	Percentage germination of seed	Non-wiry in each sowing	Wiry in each sowing	Non-wiry in combined sowings	Wiry in combined sowings	Deviation from 3:1 ratio ÷ standard deviation of simple sampling
160 (Dwarf Aristocrat)	P_2	uncontrolled		410	0	410	0	
24	P_2	"		48	0	48	0	
24-1b	P_1	"		28	0	28	0	
Dwarf Aristocratx24-1b	F_1	"		79	0	79	0	
C46-1b	F_2	controlled		180	7	180	7	6.8
C46-1b-1, 1st sowing	F_3	uncontrolled		147	30			
C46-1b-1, 2nd sowing	F_3	"		25	5	172	35	2.7
C46-1b-2, 1st sowing	F_3	"		120	2			
C46-1b-2, 2nd sowing	F_3	"		33	1	153	3	6.7
C46-1b-3a	F_3	controlled	96	52	0	52	0	
C46-1b-1-1	F_4	"	91	39	10	39	10	.75
C46-1b-1-2, 1st sowing	F_4	"	98	80	26			
C46-1b-1-2, 2nd sowing	F_4	"	76	39	9			
C46-1b-1-2, 3rd sowing	F_4	"		152	52	271	87	.31
C46-1b-1-6	F_4	uncontrolled	48	13	0	13	0	
C46-1b-1-7	F_4	controlled	89	30	17	30	17	1.8
C46-1b-2-3	F_4	"	100	27	0	27	0	
C46-1b-2-5	F_4	"	100	54	0	54	0	

leaves, the new type is called wiry. It is hereditary in nature and probably is due to a gene mutation. Wiry (w) is completely recessive to normal (W). In our cultures it has been completely sterile.

Literature Cited

1. Honing, J. A. 1923. *Nicotiana deformis* n. sp. und die Enzymtheorie der Erblichkeit. *Genetica* 5:455-476. 2 pl., 5 fig.

2. Kraybill, H. R. and S. H. Eckerson, S. H. 1927. Tomato mosaic. Filtration and inoculation experiments. *Amer. Jour. Botany* 14:487-495.

3. Serebrovsky, A. S. 1927. The influence of the "purple" gene on the crossing-over between "black" and "cinnabar" in *Drosophila melanogaster*. *Journal of Genetics* 18:137-175.

BEST HONEY LOCUST BEANS

Seventy Dollars in Prizes

THE American Genetic Association offers seventy dollars in prizes for the best honey locust beans from productive trees. First prize $25.00, second $10.00, third $7.00, fourth and fifth $5.00 each, sixth and seventh $3.00 each, eighth $2.00, and an additional prize of $10.00 for the most productive tree. Send by parcel post five-pound sample to American Genetic Association, Victor Building, Washington, D. C. Large beans, sweet beans, and heavy beans are desired. Contestants agree to send cions or other cuttings to enable the Association to propagate the tree.

The contest closed last December brought to light honey locust beans nearly a foot and a half long that had 29 per cent of sugar in them. This is more sugar than is to be found in sugar beets or sugar cane. No wonder cattle eat honey locust beans greedily. All of the very promising trees were in the Southern States and it is felt that better trees may be growing farther north.

The Honey Locust tree has a remarkable list of qualities.

(1) It is beautiful and a good timber tree with a strong, durable and beautiful wood.

(2) It is a rapid grower.

(3) Like the carob of Palestine and the algaroba of Hawaii, it is a legume gathering nitrogen from the air to make its own proteins. This also enables it to fertilize the earth for other plants.

(4) It is an open-top tree through which much light can pass to crops below, thereby favoring a two-story agriculture, like the carobs of Algeria.

(5) It is a productive tree. One correspondent tells of a tree producing six consecutive crops estimated at twenty bushels each. Mr. J. M. Preston of the Branch Experiment Station at Hays, Kansas, gathering seeds for planting, reports a tree with seven inch or eight inch trunk, producing eighty pounds of beans, and another tree in Manhattan, Kansas, from which he gathered "about four hundred pounds of pods." He reported that this tree had a trunk of two and one-half feet in diameter, broad top, and bore in 1911 and 1912, but failed in 1913.

(6) Frequent reports of consecutive crops seem to indicate that the honey locust bean is a regular bearer as trees go, and apparently it can be expected to produce crops with greater regularity than most fruit or nut trees. One correspondent says of a tree on his farm that the cows and hogs stand

under it, always ready to devour every pod that falls. The tree is very large and very beautiful. The cows improve in milk and the hogs in weight when the locust ripens, for there are always bushels and bushels on the tree.

(7) The honey locust bean is of large size. This should make the crop easy to harvest. The beans are often one foot or more in length and 17 prize beans in the JOURNAL OF HEREDITY contest 1927-28 weighed a pound when bone dry after weeks in the house.

This large size, taken in connection with their tendency to curl up, should make them easy to harvest, possibly even with a rake. Perhaps large quantities could be raked up in a short time, even on ground that was not entirely smooth. Perhaps a special rake would need to be devised. Apparently the beans could then be picked up with a pitchfork and handled somewhat like hay.

Experience with the gummy Keawe in Hawaii would indicate that some easy method of grinding these could be found. Thus another concentrated food could be added to the dietary of the American farm animals.

If the hill farmer has a chance of raking up a one ton or a two ton crop of bran material per acre from his blue-grass pasture, at the same time that he gets good pasture and an annual increment of wood, we should certainly test out the possibilities.

Genetics Humanized

WE have had, in recent years, a number of very excellent treatments of genetics for the technical student who wishes to "dig things out" in considerable detail, but there has been a lamentable dearth of readable *elementary* presentations which succeeded in giving the ordinary reader a really modern viewpoint. In this, as in other scientific fields, most books that are reputed to make the subject easy fall into (or between) one of two classes: (1) the "talky-talky" popular books which expatiate at length on the superficial and the platitudinous aspects of the subject but omit or slur over the "meat," and (2) the sugar-coated text-books, which may be human enough in their beginnings, endings, and interstices, but which, wherever they encounter knotty fundamentals, belie their promises and become, during these crucial passages or chapters, indistinguishable from out-and-out technical treatises. Altenburg's *How We Inherit** is a happy exception to both these latter categories in that it actualy gets the important principles across to the general reader in an attractive and thoroughly understandable way.

This is an important achievement because, although modern genetic principles occupy a key position in present-day biological theory, and, through this, in medicine, psychology, philosophy and the social sciences, nevertheless, very few persons other than the trained geneticists themselves have a sound comprehension of the basic concepts of heredity and of their mode of application. Progress in other fields of biology and in allied subjects is thus materially hindered, and we are presented with such anachronisms as a discussion by paleontologists of the validity of "orthogenesis," by psychologists of "the inheritance of habits," by some medical men of the effect of blood transfusion in producing "artificial consanguinity" and thus serving as a contraindication to marriage. What can we then expect of the lay public? One readable elementary book, that presupposes no biological background, may be of more help in remedying

*Henry Holt & Co., 1928.

such a situation than a series of courses for specialists, provided it can really make its readers "genetically minded."

The difficulty involved in making heredity understandable is illustrated by the fact that in many elementary college courses in the subject something like 50% of students fail, or would fail if ordinary standards of grading were maintained. A large proportion never grasp simple Mendelism, and of those that "pass" the great majority have no clear idea of the meaning of "multiple factors," essential though this matter is for modern biological concepts, and they would be unable to solve correctly a "three-point problem" in the location of a gene—being therefore incapable of appreciating the method which, more than any other, has led genetics to its present position beyond the microscope. Under these circumstances it is of little use having them memorize numberless "cases" and "ratios," or deal with the finenesses of aberrations from principles which themselves were not properly digested.

Chromosomes and Laundrymen

Altenburg's book does not make this common mistake of losing sight of the forest on account of the trees; neither is the forest dealt with abstractly. The few type cases, representative of the major phenomena, are thoroughly and vividly depicted and dissected, and the generalizations are made from them. In the process, the author displays a lucidity and directness of exposition that strikes at and makes clear the very points, essential for an understanding, which ordinarily elude the student, and he brings these points into relief with an aptness of analogy and an unpretentious freshness of expression that is rare in this age of academic bondage.

A few quotations will illustrate this. "If they [relatives] intermarry they force the bad gene to come from under cover, and if society now sees fit, it can eliminate the bad gene by preventing the reproduction of the defectives who carry it." Again: "A hybrid, it will be seen, is somewhat like a laundry. You send a collar and a shirt to it; so does some one else. You may get back your collar and your shirt, and he his; but you are just as likely to get back your collar and his shirt, and he his collar and your shirt. The laundry, however, is not quite so careful as the hybrid; for it might give you back a couple of collars and the other person a couple of shirts. The hybrid seldom makes a mistake of this sort. It . . . would see to it that you get *a* collar and *a* shirt, one member of each pair of articles, so to speak, though it would not worry about which member of each pair you got. To get back to chromosomes, one member of each pair goes to every reproductive cell of a hybrid, but it is a matter of chance which member it happens to be (see Fig. 21)."

From so un-texty, untechnical a presentation, the cursory reviewer might get the impression that the book is excessively elementary, yet, by such means, the student is led easily to the point of calculating "coincidence," of understanding the genetic interpretation of sex, the mechanism of selection, etc., with an insight that would be enviable in many an advanced course.

To attain a real "working knowledge," however, requires self-activity and repetition—the solution of problems, and so there has been provided for the student, as distinguished from the casual reader, a separate pamphlet of "reports," wherein he may attain practice in the working out of numerous cases, without these cluttering up the main arguments. The method here used embodies a distinct improvement over the usual problem method, in that for these "reports" a certain amount of guidance is provided,—just enough to make the solutions actually workable by the aver-

age student, and to spare much effort that might otherwise be misdirected profitlessly. Moreover, the student is thereby enabled to progress to much more advanced problems than would otherwise have been possible for him. In this way, through book and 'reports" combined, the serious worker can, if he wishes, gain the comprehensive, practically first-hand working knowledge characteristic of the specialist, and the publication becomes available for advanced as well as elementary uses.

Wherever feasible throughout the book the illustrations are drawn from and applications are made to human heredity, since the chief interest of genetics undoubtedly centers here, both for the student, the layman, and the scientist in some other field. And, unless such overt applications are made, the average reader is apt to lose sight of the fact that they can be made. It is one of the major triumphs of modern genetics that the science has now attained such universality as to warrant us, without hesitation, in thus applying its principles to man, even though the number of concrete instances completely sifted out in man still remains meagre. And, as the author warns us: "The Mendelian principle tells us nothing in particular about human inheritance; it is a general principle that applies to the gene, the unit of inheritance. The student of heredity cannot, by mere inspection of an animal or plant, tell us the hereditary basis of any particular trait. His position is exactly analogous to that of a person who is familiar with the principles of mechanics but who has not yet entered and studied in an engine room. The principles of mechanics underlie the operations of all machines, but the structure of these machines and their particular manner of operation are matters which demand separate study." It is these underlying principles which this book presents to the general reader in so clear a form, while the "reports" give samples of the specific mechanisms involved.

H. J. M.

RACE CHARACTERS OF THE ENGLISH

"WHAT are the characteristics of the race which seem to stand out in history? First, there is no doubt that it comes of very stout stock. Our ancestors, the Danes, the Saxons and the Normans, were pioneers, and the English have remained pioneers ever since. That accounts to a considerable extent for what it has done in the world.

"It is natural for people who are pioneers to have a real passion for individual liberty, and that stands out in our history. I think, as one of our great characteristics. Every Englishman has in him somewhere, I think, a root of being a rebel against authority. He does not like to be told what to do, he does not like to obey; and that comes from that very energy which made our ancestors pioneers, but which also made them strong individuals with a passion for individual liberty and doing as they pleased.

"I put that as one outstanding quality. That by itself would have resulted in chaos, every man going his own way. But there was something in the English race which corrected what would otherwise have been this great defect. It became permeated with a sense that order was necessary. It is sometimes said that British people like order. I do not think that they like order, but they are convinced that order is necessary."

" . . . This sense of order has made the English race equally conscious that it must have impartial authority to produce order. Impartial

authority means fair and just laws, impartially and incorruptibly administered. We started very early with the Habeas Corpus Act, and it is a matter of pride that the British in such early times established an act which laid down that no man was to be arrested by the Government without being charged with an offense and brought up for trial before the law."

"All good qualities have their defects, and one of the defects of our very independence of individual character has been that the English have not been a very teachable people. We have, in a way, remained amateurs. I can understand the German point of view about us—that we have been a nation of amateurs, rather than experts, in science and other things which the Germans have specially organized for themselves.

"In a sense we have been amateurs; we have not been ready to organize, and we have not individually made ourselves such great experts as some other nations have done. But, if every quality has its defect, we may say that every defect, almost, has its compensation, and the fact that we have been a nation of amateurs rather than experts has tended to develop resourcefulness and individual initiative.

"Furthermore, the English race has been essentially a practical people, which again has its qualities and its limitations. A practical people does one thing at a time, and it does not select for its energies anything but what it feels is within the compass of its power to achieve.

"Having done one thing at a time, it makes that a strting point for the next, so that it has continuity of action. You may say the empire was built up, not by planning, but by doing one thing and then finding that that one thing led on to another thing."

. . . "We get angry when foreign nations say we are a materialistic race, a nation of shopkeepers and so forth. We do not think that a true judgment of us, because we are conscious that there is a real moral sense in the English race; but, at the same time, we ought to remember that there is a very real strain of materialism in us, too."

. . . "Though we are quite capable of responding to ideals and have a real moral sense, when you look through our history—and it is no discredit to us—the fact is that we have had to deal with practical problems and find solutions; and it is because we are a practical people that we have found solutions, rather than the fact that we have gone out into the world as crusaders with any ideals we cherished at the moment.

"We have been lacking in imagination. Perhaps it is true that almost every race lacks imagination. But we, at any rate, have not had great plans. I think there are other nations that have had much greater conceptions than we have of policy, and so forth. I am inclined to think that, though our lack of imagination has not made us a very popular people in the world, at the same time that very thing has contributed to the particular things we have achieved in our public life."

"If I were to sum up in one sentence the quality which has most helped the British race in its development, I think I would put it in this way: That it has been the power to combine with the passion for individual liberty the sense of the necessity of order."

Viscount Grey of Fallodon, "Explaining the English," in *The Baltimore Sun*, Feb. 19, 1928 (p. 6).

CHROMOSOME ABERRATIONS AND THE IMPROVEMENT OF ANIMAL FORMS*

CALVIN B. BRIDGES
California Institute of Technology, Pasadena, Calif.

EXCEPT in restricted fields, the prospect is not bright for success in the utilization of chromosome aberrations for the improvement of living forms in accordance with the desires of mankind. That is, not with chromosome aberrations in the narrower sense, though of course almost all genetic variation owes its inception to aberration of the chromosomes, or of constituent parts of the chromosomes, especially the genes. The direct usefulness of the supragenic aberrations lies in the light they throw on the machinery of heredity and the action of genes. This hightened knowledge in the pure science will then make more certain and more rapid the course toward any improved type that is desired.

The gross chromosomal aberrations are in two widely different categories with respect to the difficulties of utilization. The division coincides with a difference in genic balance, that is, in the ratios of the genes governing the development of the various characters. In the normal haploid group, *n*, the plus and minus modifiers of each character are balanced in effectiveness.[4 5 6]

The aberrants in which the normal balance is left unchanged include the haploid, triploid, tetraploid, and other polyploid types, together with translocations, inversions and interchromosomal exchanges. The aberrants in the balanced category offer only slight physical and physiological abnormalities, and these, in the case of the *n*-variants, are of rather desirable nature, such as differences in size, in rapidity of development and of growth, and in the frequent substitution, among the polyploid races established in nature, of parthenogenetic for bisexual reproduction.

The other category includes the unbalanced types, in which the ratios among the genes have been changed through increase or decrease by some unit smaller than the basic haploid group. Any smaller unit, for example a particular chromosome or section of chromosome, would almost invariably be internally unbalanced with respect to the plus and minus modifiers of at least a few characters. Hence the addition of such a unit would shift the grade of development of characters and give rise to other peculiarities, all of which may be grouped under the term "duplication phenomena." The character changes produced by deficiencies are especially great.

Among the difficulties to be overcome in utilizing an aberration of the unbalanced category is the fact that the variant is generally a weakling which survives the hazards of embryonic development less frequently and whose career as an adult is liable to be cut short. Poor viability in a type that is otherwise highly desirable may be counteracted by an artificial environment designed to relieve the weakling from the competition for food and to guard him against the rigors of nature.

Typically, unbalanced variants occur as a fraction only of the individuals of a family, and there is a wastage because of the normal offspring. This may be met by an increase in number of parents with early elimination of the undesirable offspring.

*Contribution from the Carnegie Institution of Washington. This paper was prepared as part of the symposium on "Irregularities of chromosome behavior in relation to plant and animal improvement," held before the joint session of the genetics section with the sections of geneticists interested in agriculture at the A.A.A.S. meeting at Nashville in December, 1927. Illness of the author prevented the presentation of the paper.

Another difficulty with unbalanced variants is their frequent sterility or low productivity. However, aberrant types that are themselves completely sterile may often be produced at will by crossing appropriate fertile types. The classical example of this is the mule. In Drosophila the sterile triplo-X or superfemale type may be produced by crossing XXY females to normal males, by crossing $3n$ females to normal males and by at least two other methods.

The worker in animal material is at a striking disadvantage in the relative difficulty of propagating variants. The asexual propagation by tubers, stolons, grafts, slips, bud-transplants, etc., is an immense advantage of many kinds of plant material, enabling the perpetuation of types that are desirable even though sterile or not hardy and the broad dissemination of a given type in complete uniformity.

Moreover, in animal material an aberrant chromosome aggregate in the soma is more liable to cause total failure of gametogenesis, of the type seen in the mule. In such cases the failure extends to gametes that are of normal haploid constitution. Thus, in Drosophila, the XO males, the intersexes, the superfemales and the supermales each produces a variety of gametes including the normal haploid, but all the gametes alike are unable to function. Apparently a decisive change has been wrought on the germ cells in the prematuration stages by the unbalanced chromosome aggregate.

But, on the other hand, animal material possesses the advantage that gametes of highly aberrant chromosome constitutions are not discriminated against in fertilizing power. Thus, the $3n$ individual of Drosophila produces eggs that contain extra chromosomes in various combinations. All of these eggs are apparently on a par in fertility, though there are vast differences in the viability of the resulting zygotes. This holds even in the cases where the sterility is of the general type due to the action of an unbalanced aggregate upon the cells of the germ track. Thus, in the case of the haplo-fourth type the general gametic failure is not complete, probably because the fourth chromosome is a relatively small part of the basic group and the haplo-IV aggregate is not extremely unbalanced. Haplo-IV males are nearly normal in fertility, but about half the females are entirely sterile and the remainder are low in productivity. There is good evidence that in the semi-sterile females the nullo-IV gametes are not at a disadvantage as compared with the gametes of normal constitution.[12]

On the other hand, with plants, which have a lengthier and more important gametogenic generation, there is generally a decided difference in the functioning of gametes of different constitutions. Some constitutions are unable to function at all. An aberrant chromosome constitution has a much greater effect upon pollen than upon eggs. Moreover, there seems to be an obstacle to the fertilization of a haploid by a diploid gamete, such as that found by Blakeslee and Bucholtz in Datura crosses. In this plant fertilization rarely ensues even when the pollen that has the different n-constitution manages to reach the egg.

This difference between plants and animals has an important bearing upon the relative chance of securing aberrant types, for many of the aberrations occur in the maturation stage and come to expression only if the gamete is functional.

The bisexual dioecious reproduction that is predominant in animal material is a disadvantage as compared with the self-fertilizing hermaphroditism of plants. This disadvantage is especially marked in relation to the balanced category, which includes the types most favorable for utilization. Of the balanced types, those which are stable in gametogenesis, such as the tetraploid, are most useful. In a bisexually dioecious form, such as Drosophila, the

establishment of a tetraploid race offers almost insurmountable difficulties. Examination of the ovaries of diploid Drosophila show rather frequent occurrence of an isolated egg-string of which the cells are tetraploid, or a cyst of oogonial tissue that is tetraploid. Such an island of tissue is presumably descended from a single cell in which the chromosomes of the aggregate underwent division without being followed by nuclear and cellular division. At maturation the $4n$ cells with the doubled aggregate would yield $2n$ gametes. The obligatory cross-fertilization would then produce a $3n$ zygote if the $2n$ gamete be fertilized by a haploid X-sperm or an intersex if fertilized by a Y-sperm. The intersex may be completely male in aspect and then produces sperms that are $2n$ in constitution, but are entirely unable to fertilize. Thus, the production of the $4n$ type cannot come directly from aggregate doubling in the $2n$ form. In intersexes $6n$ cysts have been seen and such doubling might occur in the $3n$ female. At maturation a $6n$ cyst would give some $3n$ egggs, which would give $4n$ zygotes upon fertilization by ordinary haploid X-sperm. Three independent occurrences of $4n$ females from $3n$ mothers and diploid fathers have been noted. But the $2n$ eggs of those $4n$ females could only be fertilized by haploid sperm from ordinary males and gave triploid females and intersexes, which were no more useful than those already on hand. It is also possible that the $4n$ females mentioned above originated through doubling in the germ-track of the diploid male, giving a $2X2Y4A$ cyst, rather than through doubling in the $3n$ mother.

For Drosophila, the establishment of a $4n$ race that can be perpetuated presupposes the possession of a tetraploid male, that is, of a $2X2Y4A$ individual. The only feasable way of obtaining such a male seems to be to double the $XY2A$ aggregate of a normale male. If doubling occurs at the first cleavage division then such a male is produced at a stroke. Repeated attempts to effect such aggregate doubling by treatment of just-fertilized eggs with cold or chemicals have not succeeded. (Unpublished experiments of T. H. Morgan and of A. D. Bergner.)

The difficulties would not be all solved by the possession of a $2X2Y4A$ male, for it seems probable from experience with $X2Y2A$ males that the four sex-chromosomes would be distributed at random and that only half the sperms would be of the desired $2X2A$ and $2Y2A$ constitutions. Selection in each generation would be required to maintain such a stock. Attachment of the two X-chromosomes to one another would at least increase the proportion of $2X2A$ and $2Y2A$ gametes in the $2X2Y4A$ male.

In the case of a self-fertilizing plant, on the other hand, aggregate doubling in the soma of a $2n$ type might give a tetraploid flower, and self-fertilization would then give a tetraploid race without further difficulty. This difference between animals and plants in the ease of establishment of tetraploid races, referred to briefly by Bridges[4] was later noted by Gates[8] as an observed fact, and its causation has been dealt with in detail by Muller.[3]

In some animal material an escape from this impasse has occurred through the substitution of parthenogenesis with the change to a tetraploid condition, as is well illustrated by the tetraploid race of *Artemia salina*, investigated by Artom.[1] There is no good clue as to why the parthenogenesis should have occurred; but that it did, enabled the tetraploids to survive as a race and to become the sole representatives in some geographical sections.

The parthenogenesis may well have come first, as seems to have been the case with Banta's race of *Daphnia*, where a 24-chromosome type is purely parthenogenetic.[2] The normal *Daphnia pulex* has a diploid number of 8, so that the 24-chromosome type is

hexaploid, according to the cytological findings of Schrader.[18]

Vandel[20] has investigated a giant parthenogenetic race of the isopod *Trichoniscus provisorius* and has found that its cells are triploid, with 24 chromosomes as compared with the ordinary diploid type with 16 chromosomes.

In the case of the tetraploid *Artemia salina*, Artom[1] has shown that a more rapid rate of growth occurs, and in general the polyploid races are of larger size than the diploids.

This greater growth may not always be a desirable feature. In the roots of *Solanum*, according to Lesley[11], tetraploid tissue forms only slight swellings normal in growth, but in the roots of the sugar beet, Winge[12] has found that tetraploid cells grow rapidly and form the cancer-like crown-gall tumors. The $4n$ tissue of beets could be produced from $2n$ tissue by innoculation with a bacterium (*Bacterium tumefaciens*), by wounding or by chemical treatments. These similarities with cancer inception in animal types deserves attention, and is in conformity with the hypothesis of Boveri[3] that cancer is due to abnormal chromosome aggregates.

A feature of the polyploid types that is important is their relation to further variation. The general effect of polyploidy is to reduce variability due to genic mutation and Mendelian segregation and to allow chromosomal variability that would be unviable if it were a deviation from a diploid base. A recessive gene arising in a polyploid would require much longer in attaining manifestation as a homozygote and should then generally constitute a smaller proportion of the offspring, as illustrated in the high-frequency of 63 to 1 and of 15 to 1 ratios in the inbred polyploid grains. On the other hand, the deficiency of one chromosome from a $2n$ base produces such great changes as to be generally lethal, while the deficiency of the same chromosome from a $3n$ or $4n$ group may permit survival.

Species hybrids belong to a type of chromosome aberration that has been and will continue to be extremely useful. Hybridization of sufficiently different parental species gives the combination of an n with an n' group. The n' group differs from the n group. in consequence of a previous aberration, or, more probably, of a long chain of chromosomal rearrangements and genic mutations. Often indeed the difference is so great in number, size and content of the chromosomes of the basic groups that the derivation cannot be followed. Here again animal material allows less freedom of hybridization than does plant material, and the hybrids, when sterile, as is generally the case, cannot be propagated by asexual methods.

In a genus of moths, *Pygaera*, Federley[7] has shown an interesting variation of the hybrid aberration. The male of the nn' hybrid between *P. anachoracta* and *P. curtula* produces some fertile nn' gametes through the failure of synapsis of the too-unlike n and n' chromosomes and the subsequent equational division of each. If the nn' male is crossed to a $2n$ (or $2n'$) female, a triploid $2n\ n'$ type is produced. This male, in a sense, constitutes a permanent hybrid, for its sperms are mainly nn' in constitution and continue the production of $2n\ n'$ aberrants so long as the backcrossing is carried out.

The converse case of an nn' hybrid giving offspring corresponding mainly to n and n' gametes is known in plants, as are also the highly interesting double-diploids that arise from doubling of an nn' hybrid and are $2n2n'$ in constitution.

Another type of aberration that may be of value, since it determines the sex-ratio among offspring, is directed or non-random passage of chromosomes to the poles at reduction. Thus, in the $3n$ *Drosophila* the ratio of diploid female offspring to diploid males

is 6.5 to 1, while the ratio of triploid females to triploid intersexes is 1 to 6.5, where a 1:1 :1:1 ratio would be expected on random distribution. Apparently the chromosomes of the $3n$ female interact upon one another and force a nearly equal partition of the extra set of chromosomes to the two poles. That is, if the extra X goes to one pole, that pole thereby becomes relatively saturated or augmented in repulsion power and directs the remaining chromosomes to the other still unsaturated pole.

A different type of directed maturation apparently takes place in the eggs of pigeons, worked with by Riddle.[11] Here the aberration takes the form of a non-random extrusion of the W or the Z pole of the reduction spindle to the polocyte. The direction of the spindle seems to be determined by the previous metabolic state of the egg, which again is determined by seasonal and other factors. The result is a seasonal and to some extent controllable change in the sex-ratio of those pigeons in which the factors are operative. The distribution of sex-linked characters observed in this case is in agreement with the above hypothesis and is opposed. in most instances, to the hypothesis that the sex corresponding to the chromosome constitution of the zygote is reversed by some metabolic difference acting in opposition to the genes of the zygote.

The problem of artificially obtaining a greater supply of favorable aberrations calls for many methods. The technique of experimental embryology applied to the germ cells may induce doubling or unusual types of fertilization or of development, such as parthenogenesis. The aberrations of sub-n caliber may be induced by chemical and physical treatments such as those by Stockard,[19] Harrison[10], and especially the X-ray method used successfully by Muller[13] and by Goodspeed[9]. Above all, success requires a wide and accurate survey of the natural variants and eternal vigilance lest the aberrations in one's hands remain unrecognized and their usefulness wasted.

Literature Cited

1. Artom, Cesare. 1926. Tetraploidismo e gigantismo. *Int. Rev. d. gas. Hydrobiol. a. H-graphic* 16:51-80.

2. Banta, A. M. 1925. A thetylokous race of Cladocera in which pseudosexual reproduction occurs. *Zeit. f. ind. Abst-u. Vererb.* 40.

3. Boveri, Th. 1914. Zur Frage der Entstehung malinger Tumoren. Jena.

4. Bridges, Calvin B. 1921. Genetical and cytological proof of non-disjunction of the fourth chromosome of Drosophila melanogaster. *Proc. Natl. Acad. Sci.* 7:186-192.

5. ————. 1922. The origin of variations in sexual and sex-limited characters. *Amer. Nat.* 56:51-63.

6. ————. 1923. Aberrations in chromosomal materials. *Eugenics, Genetics and the Family.* Vol. 1:76-81.

7. Federly, H. 1912. Das Verhalten der Chromosomen bei der Spermatogense der Schmetterlinge Pygaera anachoraeta, curtula and pigra sowie einige ihrer Bastarde. *Zeit. f. ind. Abst-u. Vererb.* 9.

Gates, R. R. 1924. Polyploidy. *Brit. Jour. of Exp. Biol.* 1:153-182.

9. Goodspeed, T. H. 1927. The X-ray in evolution. *Cal. Monthly*, Dec., 1927.

10. Harrison, J. W. and F. C. Garrett... 1926. The induction of melanism in the lepidoptera and its subsequent inheritance. *Proc. Roy. Soc.* B 99:241-262.

11. Lesley, Margaret Mann. 1925. Chromosomal chimeras in the tomato. *Amer. Nat.* 59:570.

12. Li, J. C. 1927. The effect of chromosome aberrations on development in Drosophila melanogaster. *Genetics* 12:1-58.

13. Muller, H. J. 1925. Why polyploidy is rarer in animals than in plants. *Amer. Nat.* 59:346-353.

14. ————. 1927. Artificial transmutation of the gene. *Sience N. S.* 66:84-87.

15. Muller, H. J. and A. L. Dippel. 1926. Chromosome breakage by X-rays and production of eggs from genetically made tissue in Drosophila. *Brit. Jour. Exp. Biol.* III:85-122.

16. Navashin, M. S. 1926. Variabilität des Zellkerns bei Crepis-Arten in Bezug auf die Artbildung. *Zeit. Zell. u. Mik. Anat.* 4:171.

17. Riddle, O. 1917. Control of the sex-ratio. *Jour. Wash. Acad. Sci.* 7:319-356.

18. Schrader, Fr. 1925. The Cytology of Pseudo-sexual eggs in a species of Daphnia. *Zeit. f. Ind. Abst-u. Vererb.* 31:1-27.

19. Stockard, C. R. 1923. Experimental modifications of the germplasm and its bearing on the inheritance of acquired characters. *Am. Phil. Soc.* 62.

20. Vandel, A. 1926. Triploidie et parthenogenese chez l'isopode. *C. R. Ac. Sc.* 183.

21. Winge, O. 1927. Zytologishe Untersuchungen uber die Natur maligner Tumoren I. *Zeit. f. Zell. u. Mik Anat.* 6:397-423.

Race Characters Endure

A "New Stock" American on Racial Amalgamation

" . . . We shall have to face the fact . . . that these *is* a growing race consciousness in the American people; and we shall have to study its genesis and the causes of its more recent development. We may not dismiss it (as some of the New Stock propagandists would have us do) by calling it 'race prejudice', which is an entirely different thing. We shall also have to face the fact that the immigration problem bulks larger and larger as a *race* problem. And we must recognize that the essential danger in that race issue lies in the fact that we have armed these heterogeneous non-American stocks with a political weapon which many of them are congenitally unprepared to use, and by legislative fiat clothed legions of them with an 'equality' which flies in the face of nature and of their history.

"Now let me add that in my youth I hoped for the possibility of the absorption of racial heritages under the assimilative process of American democratic forces; not a 'synthetic' Americanism, but the original spirit and genius of our race nourished, as it were, but unchanged by new and fresh blood. Long study, observation and thought have wholly changed by views. The effect of *mass,* for instance, in the immigration of the last fifty years especially, is such as to overcome the natural assimilative forces of even a younger and less distinctly defined society than the United States. Then it has become more and more clear to me that racial characteristics do not die out, especially those subtler qualities of mind and character which profoundly differentiate the culture and the spirit of one people from those of another. These racial characteristics are transmitted from generation to generation practically unchanged, though they may lie dormant for long periods or lives, or manifest themselves obscurely or only under the stress of a conflict of racial ideals. Add to this the almost abysmal ethnic, cultural and historic differences from the American stock in some of the elements of the newer immigration; consider that the easy and rapid means of international communication today powerfully tend to keep the alien under the influences of his original civilization; and the conclusion seems unavoidable that the possibility of even an approximation of real national absorption is practically nullified.

"That all this is coming to be more and more recognized can hardly be challenged. It is evidenced, on the one hand, by an increasing unrest in certain parts of the land and a growing demand for more drastic restrictive and protective measures. It is evidenced on the other hand, by a tendency in certain New-Stock 'intellectuals,' aided and abetted by 'inter-

nationally-minded' Americans, to theorize about a future amalgamated or mongrelized Americanism. Some of these look forward with satisfaction to a 'Synthetic America' or a federated United States composed of racial groups living side by side as the English and French in Canada. Others among them actually exult at the thought that 'each of the races that we now know on this soil' (and that writer includes the yellow and brown races) 'will have its share of 'ancestral responsibility' for the typical American now in the making'.

"I, for one, am against all these. I am not, even remotely, of Anglo-Saxon or Nordic stock. But this is my country. And the test of service and devotion for the New Stock may be, after all, not how much we give of ourselves, but how much of ourselves we deny. The task and the call for us all—Old Stock and New—as I vision it is to strive to keep America as it was, and, as I pray with all my mind and heart, it may ever be.

* * * * * *

"It is surprising how the American people, who have given so much interest and study to the biologic and ethnological sciences, should not have more readily, and more generally, realized the incidence of those sciences on the problems of immigration. Only in the case of those racial stocks *outwardly marked* by striking and obvious physical differences (such as the black and yellow races) have they begun to awaken to the fact of the persistence of natural or *physical differences.* Even more hesitant have they been in recognizing the persistence of differences in *mental* and *moral characteristics;* and it is not without significance that the Americans who have been more reluctant to recognize the persistence of these racial differences are largely those living outside the areas where the black and yellow stocks reside.

"Yet there is a great body of scientific data and of scientific opinion not only for the erudite, but for those who care only for popular and sympathetic or 'human' study of the question of heredity. . . ."

(Speranza, Gino. *Race or Nation,* pp. 30-33, 193-194.)

The views expressed by Mr. Speranza are not those of a theorist. We quote this list of his accomplishments, mostly dealing with the question on which he writes in *Race or Nation,* from *Who's Who,* Volume 12.—*Ed.*

Gino Speranza, lawyer; born in Conn., Apr. 23, 1872; son of Prof. Carlo L. and Adele (Capelli) S. . . . general legal adviser to Royal Consulate-Gen. of Italy, in New York, for 15 years; as member Law Com. of Prison Assn. of N. Y. assisted in drafting probation law of N. Y. State. Appointed by Gov. Hughes as member State Immigration Commn.; spl. Agent Royal Italian Embassy to investigate labor camp troubles in West Va., 1906. Dir. Prison Association of N. Y. Soc. for Italian Immigrants; chairman Com. on Crime and Immigration of Am. Inst. Criminal Law. Volunteered his services to the U. S. Govt. and assigned as asst. to mil. attache of Am. Embassy at Rome; later attache of Embassy, in Polit. Intelligence Div.; spl. corr. in Italy for *The Outlook* and *New York Evening Post.*

Metcalf Will Case Still Pending

At the present time we are advised by counsel that discussion of the Metcalf case in the Journal might complicate matters. We will, therefore, have to ask the members of the A. G. A. to bear with us until a further statement can be issued. It is hoped that it will not be long before this can be done.

ROOTED COTTON CUTTINGS
Figure 7

In breeding work it is often desirable to carry over certain plants from year to year, or to propagate them. Cotton breeders do not appear to have used vegetative propagation heretofore, so that the success of this experiment may be of value to others.

ASEXUAL REPRODUCTION OF COTTON

H. E. Rea

Texas Agricultural Experiment Station

ASEXUAL reproduction by means of cuttings has long been practiced in propagating horticultural plants but it is a much less common practice with agronomic crops. Such a method has recently been employed in maintaining certain strains and varieties of cotton for breeding purposes and for studies in resistance to the cotton root rot disease.

The cotton root rot disease (*Phymatotrichum omnivorum*) causes enormous annual losses to the cotton crop. Perhaps the most promising method of approach in the control of this disease is that of breeding resistant varieties. Unfortunately, there are no varieties yet known which are wholly resistant to the disease, so that the best point of attack seems to be the identification and propagation of resistant strains from populations which are preponderantly susceptible. Often such stalks as appear resistant are discovered late in the season after the cotton has already been harvested, and even in cases where seed are available, there are many chances that they have been contaminated by pollen from susceptible neighboring plants at the time of fertilization. In a search for such resistant plants it became evident that a practical method of propagation by which they could be maintained with their original genetic constitution intact would be desirable and perhaps necessary. Asexual propagation of cotton was attempted and the preliminary trials have been so encouraging that it seems worth while to record the results for the benefit of other workers who are confronted with similar problems in cotton breeding.

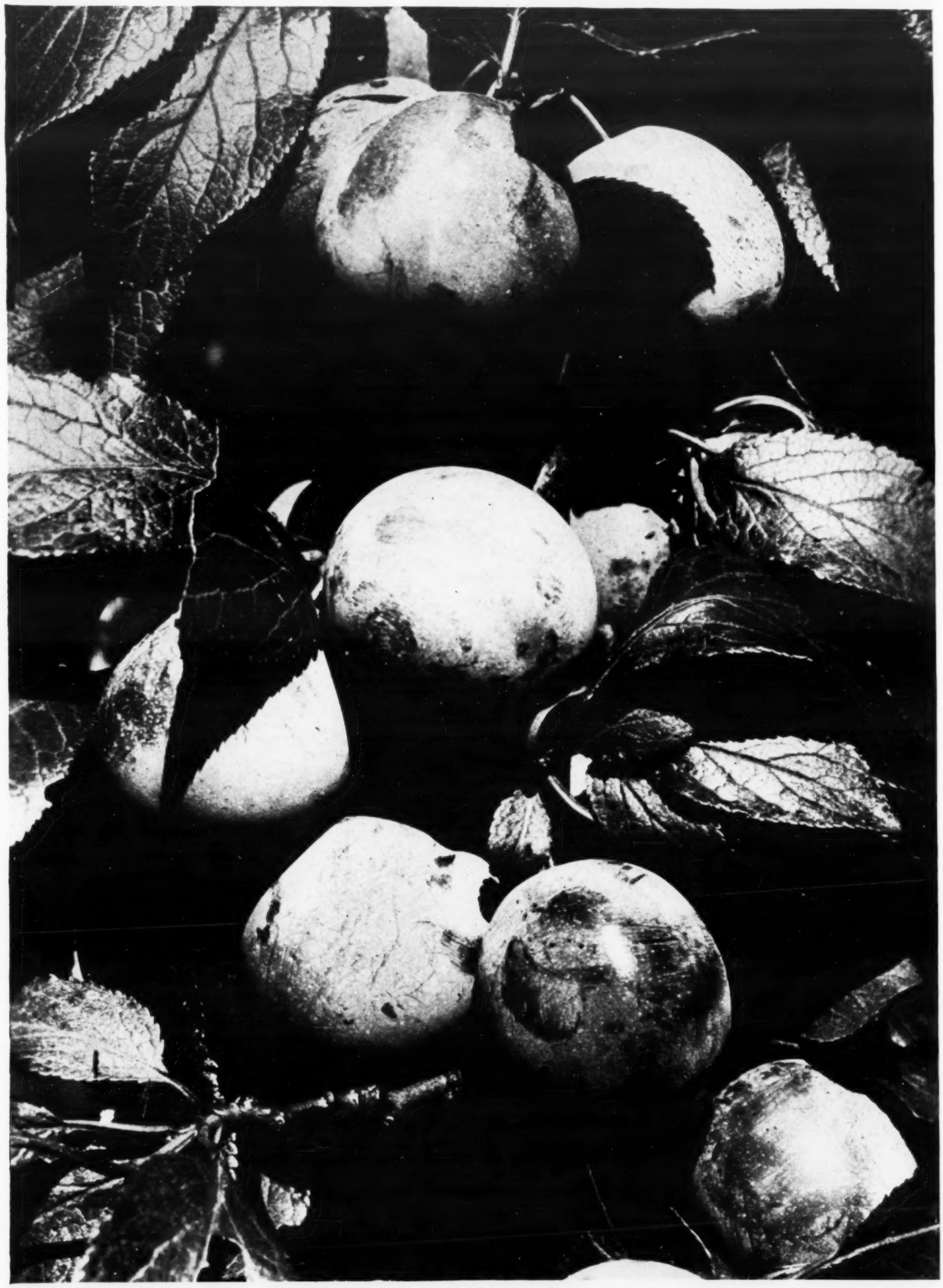
On August 15, 1927, a total of 2000 cuttings were made from stalks of Belton cotton. Vegetative branches, fruiting branches, and portions of the main stems were used indiscriminately. Hard wood and soft wood cuttings were made from each location on the stalk and various types of cuts were made from each class of cuttings. The program of taking the cuttings was varied with the hope that conditions would be favorable for the rooting of some of the groups. The cuttings were kept in moist sand until they were calloused over and were afterwards potted in soil.

Although nothing was known about the optimum requirements for cotton cuttings, and the facilities for applying bottom heat, generally regarded as essential in rooting cuttings, were not available, the cuttings showed a high percentage of callousing and a fair degree of rooting, as indicated by the following figures and the accompanying photograph:

Date of Observation	*Total Examined*	*Dead*	*Alive and Calloused*	*Number Rooted*
September 3	100	10	89	1
September 15	2000	1157	816	27
October 8	2000	1394	520	86
October 21	2000	1612	263	125

The heavy loss of cuttings after callousing was undoubtedly due to handling to observe development. The results indicate, however, that cotton can be rather easily propagated by cuttings and, when optimum conditions are determined and provided, a much higher percentage of rooting may easily be expected.

A sexual reproduction of cotton showing callouses and root development of the cuttings.



THE BURBANK PLUM

Figure 8

This variety was one of the twelve seedlings which Burbank raised from seed sent him from Japan. The Burbank variety was named in 1887, and it spread rapidly throughout the country. In 1924, 68,063 crates of Burbank plums were shipped from California, 14,000 more than any other variety

BURBANK'S RESULTS WITH PLUMS*

D. F. JONES,

Connecticut Agricultural Experiment Station, New Haven, Conn.

THE gold-seekers first made California widely known but the fruits grown in that favorable climate have returned more wealth to the state than has been taken out in the form of precious metals. The plum, which also includes the prune, is one of the most important fruits in that section, ranking close to the peach and the orange. More than half a million crates of fresh plums are shipped from California each year and a larger quantity are dried and canned.

Mr. Lloyd Austin has made a survey of the plum varieties which make up the fruit shipped out of the state. In an article published in the *American Fruit Grower Magazine* (Sept. 1925) he has shown that in 1924 the eight leading shipping organizations located in the main producing centers sent out 557,435 crates made up of

TABLE I—Importance of Burbank's Plum Varieties in California

As shown by the number of crates and boxes shipped in 1924 by eight of the leading shipping organizations located in the main producing centers, including Vacaville, Winters, Sacramento, Newcastle and Loomis, California, as compiled by Lloyd Austin in the American Fruit Grower Magazine, September, 1925. Asterisks (*) indicate Japanese varieties and Japanese hybrids.

Rank	*Burbank Varieties*	*No. of Crates*	*Percent of Total*
1	Burbank*	68,063	12.21
2	Wickson*	54,902	9.84
3	Climax*	54,376	9.75
5	Santa Rosa*	46,725	8.38
7	Giant	42,092	7.55
8	Beauty*	36,418	6.53
10	Formosa*	21,750	3.90
12	Gaviota*	19,808	3.55
13	Duarte*	18,579	3.33
17	Appex Plumcot*	4,364	.78
19	Standard	2,710	.48
20	Satsuma*	2,402	.44
21	Sugar	2,360	.42
24	Shiro* (Early Gold)	1,098	.19
	9 other varieties	447	.07
	Total	376,094	67.42

Rank	*Other Varieties*	*No. of Crates*	*Percent of total*
4	Diamond	48,200	8.66
6	Grand Duke	46,108	8.27
9	Kelsey*	22,708	4.09
11	President	21,439	3.84
14	Pond	10,773	1.95
15	Calif. Blue	9,995	1.79
16	Tragedy	7,754	1.39
18	Red June*	3,003	.54
22	Botan*	1,692	.33
23	Clyman	1,539	.28
	58 other varieties	8,130	1.44
	Total	181,341	32.58

*The writer wishes to acknowledge his appreciation to Mr. John T. Bregger of the Horticultural Research staff of Stark Bros.' Nurseries and Orchards Company for his criticism of this article and for the accompanying photographs.

THE BREEDER AND SOME OF HIS CREATIONS

Figure 9

Luther Burbank beside some of his new hybrid plums, photographed about 1906. The few score varieties introduced to the trade by Burbank were selected from literally millions of seedlings.

91 different varieties as shown in the accompanying table.

Fourteen of the 24 leading varieties are originations of Luther Burbank. Ten of the leading varieties and 58 of the minor sorts are from other sources. Many varieties have been tried out and are being discarded but some of these less desirable trees are retained as long as they are fruitful. The Burbank varieties furnished 67 per cent of the total amount of shipping plums for that year. Of the plums of Japanese type, 92 per cent of the production is from his varieties and it is this group of plums that he has worked with most extensively.

The shipping plums are selected principally for large size, attractive coloring, and ability to withstand distant transportation. They are mostly plums of the Japanese type and not of the highest quality. They are grown in comparatively small sections of the state which are especially adapted to the growing of early fruit. Placer County is the leading plum-growing section of California. A survey of the number of bearing and non-bearing trees of each variety was made in 1923 by Farm Advisor Roy D. McCallum and given by Austin in the *American Fruit Grower Magazine*. The four leading varieties in each class are arranged below in order of the number of trees.

Bearing Trees

Rank	*Variety*	*Type*	*Originator*
1	Diamond	European	Diamond or Hooker
2	Burbank	Japanese	Burbank
3	Santa Rosa	Japanese	Burbank
4	Wickson	Japanese	Burbank

Non-Bearing Trees

Rank	*Variety*	*Type*	*Originator*
1	Duarte	Japanese	Burbank
2	President	European	Rivers
3	Beauty	Japanese	Burbank
4	Burbank	Japanese	Burbank

Of the four most important bearing trees, three are Burbank varieties. The most numerous variety, Diamond, is the only one of different origin, coming from England. The non-bearing trees show the present consensus of opinion as to the most profitable varieties as these are the young trees recently planted. The most popular plum in that section is now Duarte, a recent addition to the list of Burbank varieties. Three of the four favored sorts came from Santa Rosa.

In Hedrick's monograph of the *Plums of New York* there are listed 208 major varieties out of some 1,500 named sorts described. Some of the more important ones are of historical interest only and others have been included because they have possible value for breeding purposes. Those fruits that are now grown are the pick of the whole world and the heritage of the many centuries since plums were first cultivated. It is therefore notable that 21 of these more valuable plums have originated with Luther Burbank within the last 40 years. Many widely grown fruits of his workmanship have been introduced since 1910 when this book was published.

This list of 21 names does not include Abundance, Maru and several other plums which were introduced by him from Japan. Abundance is grown almost everywhere and is one of the most popular varieties. Its introduction is in itself a most creditable achievement. Burbank and Satsuma were selected from 12 seedlings which the California plant breeder had sent to him from Japan. They are acquisitions of first importance no matter how much the element of chance may have entered into their discovery. Burbank's work with plums is often belittled by referring to his varieties as introductions. A few of them are, to a certain extent, but according to the statistics from California these earlier varieties are now being supplanted by others that are solely the result of crossing and selection carried on at Sebastopol.

The famous 12 seedlings were first grown in 1883 and the Burbank variety was named by the pomologist of

PLUM TEST TREE

Figure 10

The plum tree on the left has about fifteen varieties topworked on it by Luther Burbank for comparative test. At the right is his office at the Goldridge Experiment Farm.

THE AMERICAN PLUM

Figure 11

One of Burbank's prolific and rapid-growing originations. This tree is said to be two years old from transplanting.

the United States Department of Agriculture in 1887. It was offered for planting by the nursery trade in 1889. These scraggly, wide-spreading trees are seen in almost every home orchard throughout the country. They are enormously productive and when properly grown are attractive in appearance of fruit and of good quality. Although it is not a high quality plum, it has raised the standard in many parts of the country that before were able to grow only the native sorts.

Wickson and Santa Rosa have been considered to be two of the most profitable commercial varieties in the past on account of the size and attractiveness of fruit. Wickson is one of the largest of all plums and is one of the best known of Burbank's varieties. It was first offered for sale in 1893. The parentage is in doubt but is considered to be a selection from a cross of Kelsey by Burbank. Writing about 1914, the originator stated that he considered Santa Rosa, Formosa, Beauty, and Wickson his four best plums.

Luther Burbank gave most of his attention to the varieties of *Prunus salicina* and *P. Simonii* parentage. The quality plums are mostly of European sources belonging to the *Prunus domestica* group. It is most notable that one of the varieties of this type of the best quality, Pearl, is a Burbank variety. Hedrick says:

> Its rich, golden color, large size, fine form, melting flesh and sweet, luscious flavor, place it among the best dessert plums. In the mind of the writer and of those who have assisted in describing the varieties for the "Plums of New York," it is unsurpassed in quality by any other plum.

As might be expected of such a fine variety, the trees are unproductive. Pearl was introduced by Burbank in 1898. It is a seedling of the Agen prune, the pollen parent being unknown.

The Bartlett plum has been the source of considerable merriment to the Burbank critics. Harwood in "New Creations in Plant Life" speaking of this variety said that:

> It has a flavor wholly distinct from the plum, in fact it is not to be distinguished from the Bartlett pear. So marked is this characteristic that when one of the foremost fruiterers of the world tasted the plum blindfolded, not knowing what manner of fruit he was eating, he pronounced it unquestionably the finest Bartlett pear he had ever tasted.

Patrick O'Mara's comment on this is that "the man who doesn't know a plum from a Bartlett pear when he takes it in his hand is not much of an expert." The laugh, however, is on O'Mara since it is quite possible to make a test without knowing what manner of fruit one is eating. The description of this variety in the "Plums of New York" reads: "The Bartlett pear flavor is agreeable."

The Stoneless Plums

Much has been written about Burbank's attempt to remove the stone from plums leaving only an edible nut imbedded in a luscious fruit. The Miracle variety, "the plum without a pit," was sold to the Oregon Nursery Company in 1903 and introduced by them in 1906. Conquest, another variety of this type, was introduced to the fruit growers by Burbank in 1916. According to Hedrick, Luther Burbank imported from a French nurseryman a tree of the Prunier Sans Noyau or Stoneless plum, known as a curiosity in Europe for at least three centuries. This was crossed with several of the best European varieties and several stoneless fruits from the second generation segregates were grown in 1893. It was not until 1899 that a fruit appeared that was considered good enough to introduce. It resulted from the cross of Stoneless by Agen and is said to be almost entirely without any hard covering around the seed. Hedrick states that this variety as grown in New York differs very little from the original stoneless plum. It is not now generally listed in nursery catalogs and

has evidently proved to have little value. The idea is certainly commendable and we may well hope that in time a good fruit of this type may be grown.

Plum-Apricot Hybrids

The plum and apricot hybrid has been the subject of some controversy. Burbank claims that a cross was made between a variety of Japanese plums and an apricot. DeVries describes some of these fruits in his *Comments on the Experiments of Nilsson and Burbank* (1907, p. 218).

> The hybrids of the plums and apricots are called by Burbank plumcots, and a certain number of these most delicious and beautiful fruits I have seen on his farm at Sebastopol. They have the outer appearance of apricots but combine the rich and varied colors of the prunes with the soft indument of the former. Dark blue and downy apricots are as striking a novelty to the eye as the combination of the flavor of prunes and apricots in one fruit is flattering to the taste. Some had a yellow fruit flesh, in others it was red or pink or nearly white. The dark red varieties seemed to me the most juicy, and were, perhaps, next to be definitely selected. Some plumcots have free stones, but others were cling stones. In many other respects, striking differences were observed, giving an almost complete material for his selections. It is difficult to tell whether the range of possibilities of the crossings of plums has reached its ultimate limits or whether it will afterward assume still more astonishing aspects. The cross between apricots and the Japanese plum has been attended with difficulty, and has succeeded only by the use of distinct varieties.

Of the two varieties which have been named and offered for trial, Rutland and Apex, the exact parentage is unknown and their crossbred nature is assumed from the appearance of the trees and fruit. Burbank, in the fourth volume of *How Plants are Trained to Work for Man* (1921, p. 187) says:

> Apricot flowers were dusted with plum pollen and plum flowers with apricot pollen. But for a long time the experiment failed. Finally, however, when about to despair of success, several crossbred seedlings were found among a lot grown from the seeds of a Japanese plum that had been pollenized with various apricot blossoms. The young seedlings could be early distinguished readily from the uncrossed seedlings by the foliage, bark, buds, and general appearances; differences being noticeable while the seedlings were still less than a foot high. The combined characters of the plum and the apricot were to be noticed in the bark, the leaves, the buds and especially the roots. The apricot root is bright red while the plum root is yellow, pale-yellow or almost white. The hybrid seedlings had red roots, of various shades.

The fact that "uncrossed seedlings" were grown from this seed shows that the pollination was not controlled so that it is by no means certain that the seedlings with apricot characteristics came from pollen of such trees. Apricots and plums are related fruits belonging to the same genus and tend to vary toward each other. One species of plums, *Prunus simonii*, is called the apricot plum. In tree characters it resembles the peach more than the other plums and the fruit is as much like apricots or nectarines as plums. This species has been successfully crossed with the Japanese plum and is systemmatically classed as a plum.

The Apex "Plumcot" has been grown at the New York Experiment Station at Geneva and according to Wellington (*Tech. Bull.* 127, 1927) is a typical *Prunus salicina* and Hendrickson in California classifies it with the varieties of that species. The cross of plum and apricot is still more doubtful in view of the fact that Wellington failed to produce viable seed in many crosses of apricots with Japanese and other species of plums. Neither will the Japanese plums cross successfully with the European plums to which they are much more closely related. This, of course, does not prove that the union cannot be made. One can never say that. At the Connecticut Agricultural Experiment Station we have produced well developed fruit and apparently good seed from the application of apricot pollen to the emasculated and bagged flowers of the Abundance plum. None of this

RESULTS OF PLUM BREEDING

Figure 12

One of Burbank's complicated purple-fleshed hybrid plums in comparison with one of its ancestors, the native *americana* plum of the Middle West.

seed has germinated. Some horticulturists who have grown plumcots are fully convinced that they combine features of both fruits. It is possible that certain varieties under special conditions will produce an occasional viable seed but until this is confirmed, the cross must be considered unproved in spite of the firm belief that Burbank had in this new fruit . He spoke of the astonishing number of variations in the second generation seedlings and the tendency of plum factors and apricot factors to segregate in the second and succeeding generations together with the production of sterile forms.

A plant having completely, or nearly so, the characters of one or the other parent is possible from a species cross as shown by several well controlled investigations with various plants, particularly by the results of East, and of Goodspeed and Clausen, with Nicotiana species. The fact that the "plumcot" is largely plum-like in its botanical features is not necessarily evidence that the cross was not consummated. Its practical value, however, would be limited, as seems to be the case with the varieties so far produced.

Burbank's Prune Varieties

Among the *domestica* plums which are sold fresh or dried as prunes, Burbank's Giant, Sugar, Standard, Splendor, Conquest, Pearl, and other varieties, have some commercial importance. Probably it is too soon to know how valuable these may become.

One of the leading California nursery companies in its list of six prunes includes only one Burbank variety, Sugar, and of it they say: "It is distinguished as a heavy bearer. As a prune it has little to commend it." Most of the trees grown for dried fruit have been imported originally from France. A new variety called the Burton which has recently been developed by Mr. R. E. Burton at Vacaville, California, is spoken of very highly.

Many other varieties besides these named specifically have been put out from Santa Rosa either directly to the growers or to nurserymen. In some cases, possibly, varieties have been renamed and their original source lost track of. The Burbank plums are listed in practically every nursery catalog in this country and in many foreign countries as well. The Fancher Creek Nurseries offer 21 varieties of which 9 are Burbank's. According to Austin a catalog from Australia gives 28 varieties of Japanese plums of which 13 can be credited to Burbank. In the same catalog of the list of plums of European type there are 5 varieties of that origin.

Many of Burbank's plums are first generation hybrids between well known sorts that already possessed merit, some of these are of his own development from previous crosses. In some cases the parentage is very complex, representing many types and several species put together by numerous successive crosses. Immense numbers of seedlings have been grown and tested by grafting on to bearing trees. Burbank states that seven and a half million seedlings in all have been grown. We may well believe that wisdom and good fortune both attended the selection of the material worked with, and skill to a high degree was developed in selecting the particular trees to be saved and propagated.

With many crosses to make in a short blooming season, no elaborate technique of pollination could be used. Pollen was often carried on the fingers and applied to flowers that had not been emasculated or bagged. Records were lost as records sometimes are lost in the most methodical institutions. The parentage is doubtful in some of Burbank's varieties as he readily admits. The wonder is that the pedigree of so many is complete. Burbank was after results and he got them. His methods were well adapted to the purpose he had in view. A

AN UNNAMED VARIETY

Figure 13

One of the 120 new varieties of plums found among Burbank's seedlings after his death. Of the hundreds of plum varieties that have been originated in the last century those produced by Burbank occupy a leading place.

BURBANK'S CHERRY TEST TREE

Figure 14

This tree was extensively used by Burbank in making comparative tests of cherry varieties. At one time it had over 300 selections under test topworked on its branches.

greater refinement would have dissipated his efforts. In realizing the importance of dealing with large numbers upon which to base selection and having the ability to put this into practice, Burbank showed a real genius.

Other Plum Breeders

To properly evaluate his work with plums we should know what others have done with this fruit.

H. A. Terry, after living in New York, Michigan, and Connecticut, finally engaged in the nursery business at Crescent, Iowa, in 1857. For fifty years he spent much of his efforts in improving fruits and flowers, his greatest success being with plums and peonies. He worked mostly with native species and over fifty varieties have been originated by him. Hedrick in his monograph on plums from which this account of Terry's work is taken, lists Gold (not the Gold or Golden of Burbank) Hammer, Hawkeye, Nellie Blanche, Crescent City, Downing and Milton as the best known varieties. For varieties of their species many of these have not been excelled. There is no record of his methods of producing these as well as the more than 100 varieties of peonies which he has originated.

About 1870 J. W. Kerr at Denton, Maryland, began to collect all the varieties of plums that could be grown in that climate. He tested most of the varieties of American and oriental species and has done much to popularize and improve native plums. Choptank, Sophie and Maryland are his best known varieties.

Of the high quality plums of the European or *Prunus domestica* type many good varieties have been originated by Thomas Rivers and other members of the same family that have been engaged in the nursery business of Sawbridgeworth, England, for more than 200 years. One of his productions, President, is in the list of most popular varieties in California and in the trial grounds at the Geneva Station in New York it is very promising. Other valuable varieties, such as Arch Duke, Grand Duke, and Monarch, are also a few of his productions that do well in this country. Many more are widely grown in the British Isles and European countries for which places they have been primarily developed.

At the South Dakota Experiment Station, N. E. Hansen has produced a large number of named varieties of plums from native species that make fruit growing possible in that part of the country where many varieties fail. Since 1907 nearly fifty varieties of plums have been distributed and are being widely grown in the upper Mississippi valley.

One of the most extensive and carefully controlled plum breeding experiments has been carried out at the New York Agricultural Experiment Station at Geneva by Richard Wellington. Over 300 different crosses have been made between varieties that represent most of the cultivated species. This breeding work has been made possible by the finest collection of plum varieties that has ever been made and has utilized the knowledge gained from a careful comparative study of nearly all known varieties. Crosses were planned to bring together the most important characters that were known. Thousands of crossed seeds have been planted and several hundred seedlings fruited of which the exact parentage is known. Out of these three named varieties have been sent out for trial to fruit growers and these are very promising. Several combinations of species which Burbank claims to have made, produced no viable seed. The cross of Japanese plums and apricots was attempted in 22 different combinations of varieties, of European plums and apricots in 9, and some other species of plums with apricots were tried. Many flowers were pollinated in each case but only five seeds of one cross ripened and these failed to grow.

European and Japanese plums failed to give any definite hybrids after repeated trials and some other crosses of different plum species likewise proved to be impossible.

The Minnesota Agricultural Experiment Station under the direction of M. J. Dorsey has made an extensive study of winter hardiness in plums, crossing several of the native American species with the Japanese type of plums. Information as to the mode of inheritance of cold resistance is made available and on this foundation others can build.

The work of the experiment stations is different from that of Burbank, Terry, Kerr and others. The efforts of Burbank, with plums especially, have been almost wholly practical in their outcome. He obtained results, in this particular field more than anybody else, but what little information as to how he got these results is confusing. The stocks that went into the crosses that produced many of his new fruits are unknown and the parentage of others is decidedly questionable. Thus it will be seen that Burbank's achievements in plum breeding, and in other lines as well, must be measured largely by the new and better varieties he brought to life since there is little that he has done that is helpful to others working in the same field except that inspiration that comes from real accomplishment. Statements are often made or inferred that Burbank has done more than all other plant breeders to improve our fruits, flowers and other cultivated plants. This is possibly true with plums but is certainly not true in many other fields, as is well known.

Burbank's uncontrollable characteristic of overstatement, his uncritical attitude toward his own work and gross exaggeration of facts together with the misstatements and ridiculous nonsense of Harwood, Wickson and some of the other writers about Burbank and his work have naturally led to an overly critical attitude on the part of most geneticists and horticulturists as to the real merits of a man who was sincere in his efforts, personally charming and extraordinarily industrious. The carefully written accounts by DeVries, Jordan and Kellogg, and especially the recent splendid biography by Burbank and Hall, "The Harvest of the Years," should do much to correct the unfortunate impression of Burbank's work that seems to be gaining ground in scientific circles. The many valuable varieties of plums that Luther Burbank has made available to the whole world form a convincing testimonial as to his ability as a practical plant improver in this field.

Literature Cited

1. Austin, Lloyd. 1925. Burbank's contributions to the fruit industry. *American Fruit Grower Magazine,* Vol. 45, Sept. No., p. 5.
2. Burbank, Luther. 1921. How plants are trained to work for man. Vol. 4, p. 187. New York: P. F. Collier and Son Co.
3. Burbank, Luther, and Hall, Wilbur. 1927. The harvest of the years. Boston and New York: Houghton Mifflin Co.
4. East, E. M. 1921. A study of partial sterility in certain hybrids. *Genetics* 6:311-365.
5. Goodspeed, T. H. and R. E. Clausen. 1917. The nature of F_1 species hybrids between *Nicotiana sylvestris* and varieties of *Nicotiana tabacum* with special reference to the conception of reaction-system contrasts in heredity. *Univ. California Pub. Botany,* 5.
6. Harwood, W. S. 1905. New creations in plant life. New York: Macmillan Co.
7. Hedrick, U. P. 1911. The plums of New York. 18th Annual Report of the *New York Agric. Exper. Sta.* 1910. Vol. 3, Part 2.
8. Hendrickson, A. H. 1922. Further experiments in plum pollination. *California Agric. Exp. Sta. Bull.* 352.
9. Jordan, David Starr, and Kellogg, Vernon L. 1909. The scientific aspects of Luther Burbank's work. San Francisco: A. M. Robertson.
10. O'Mara, Patrick. (No date.) Luther Burbank, a short review of his work in plant hybridization and brief comparison with other hybridizers. Jersey City, N. J. Pub. by author.
11. DeVries, Hugo. 1907. Plant breeding, comments on the experiments of Nilson and Burbank. Chicago: Open Court Pub. Co.
12. Wellington, Richard. 1927. An experiment in breeding plums. *New York Agric. Exp. Sta. Tech. Bull.* 127.
13. Wickson, E. J. (No date.) Luther Burbank, man, methods and achievements. Reprinted from *Sunset Magazine.* San Francisco: Southern Pacific Co.

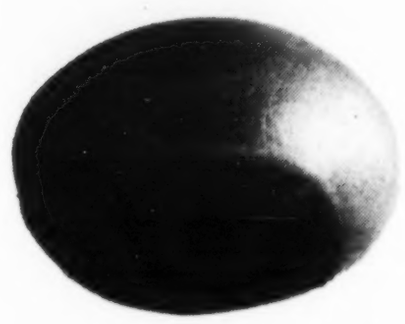
SIAMESE TWINS IN SOYBEANS

Figure 15

There are two plants represented in this picture although the actual structure could pass for a single plant. It is the result of the fusion of "twin embryos" and the branch at the right has become dependent upon the root system of its sister. The twin plants are not identical, however, because they have inherited several different characters. The branch at the left had purple flowers and black pods while the branch at the right had white flowers and brown pods. These twins resulted from the seed with double embryos shown in Figure 16.

SOYBEAN SEEDS WITH TWO EMBRYOS*

F. V. OWEN, *Maine Agricultural Experiment Station*†



TWIN SOYBEAN EMBRYOS

Figure 16

Two soybeans are enclosed within this single seed coat and one pair of cotyledons is green and the other yellow. This condition was possible because the bean was borne by a plant that was segregating for cotyledon color. Thus the two embryos are twins but not "identical twins." The female parent produces a certain percentage of double-embryo seeds and this condition has also been inherited in the hybrid offspring. Magnification 4 × natural size.

WHILE studying the inheritance of cotyledon colors in soybeans occasional seeds were found that contained two embryos. These seeds might easily pass without being detected, because there is generally nothing unusual about the size and shape, but they can be identified quite readily after attention is called to the visible outline of the cotyledons, providing the seed coat is sufficiently transparent.

It is not known just how general the occurrence double seeds is, but one variety seemed especially susceptible to the condition. This was a Chinese variety obtained from W. J. Morse of the United States Department of Agriculture and given the arbitrary number C4 in the records of the Genetics Department of the Wisconsin Agricultural Experiment Station. This variety has bright green cotyledons as well as bright green seed-coat color, and it was used as parental material in numerous crosses.‡

After a few twin seeds had been observed, a careful search was made of a composite lot of 5,000 seeds to get some idea of the frequency of accurrence. From the sample of 5,000 seeds 22, or 0.44 per cent, were of the double embryo type. A similar search in a number of other varieties, including the Mandarin, Manchu, Aksarben, and Ito San failed to reveal a single double-embryo seed. It is not to be inferred, however, that this condition does not exist in other varieties, because occasional double-embryo seeds have been seen in Mandarins and Manchus, but the figures probably have some significance with regard to the relative frequency of occurrence. Some hereditary potentiality apparently exists for this abnormality in the C4 variety.

The same tendency was also ob-

*From the Department of Genetics, paper No. 91, Wisconsin Agricultural Experiment Station. Published with the approval of the director of the Station.

†OWEN, F. V. 1927. Inheritance studies in soybeans I. Cotyledon color. *Genetics* 12:441-448.

‡————————. 1927. Inheritance studies in soybeans III. Seed coat color and summing up of all other mendelian characters thus far reported. *Genetics* 13:50-74.

served in F_2 and F_3 seeds from crosses between C4 and other varieties. The relatively small number of seeds that exhibit the abnormality made a genetic study impossible, but nevertheless it was quite apparent that the endency was inherited in some fashion.

The most striking exhibition of the double embryos was in progenies segregating for green and yellow cotyledons. Quite frequently a seed would be found, as shown in Figure 16, where one pair of cotyledons would be green and the other yellow. This naturally gave a clue to the origin of the double seeds, for while the latter may be considered twins, they are not identical twins, but are truly independent embryos enclosed within one seed coat. This point is established because of the fact that all "twin beans" that were grown to maturity showed independent segregation, and this statement applies to a total of 20 heterozygous double-embryo beans. The so-called twins were not alike in any case; hence, it is very probable that two ovules were formed and fertilized independently.

It was also of interest to germinate the double embryo seeds and to grow some to maturity. Most of the twin embryos could be separated after germination, so that each could grow to be a separate plant, but there were occasional attachments that were hard to break. In some instances the root system of one embryo would fail to become well established, so that one plant would be largely parasitic upon its "twin sister." Figure 15 shows a photograph of just such intimate attachment.

Measuring Mental Differences

This book* is of particular importance to all people working in the domain of individual differences because Spearman is one person in this field who has rendered himself conspicuous by remaining consistent. He has continually said that the factors producing scores on the different parts of a 'mental' test were of two kinds; one factor which was common to all parts and which produced the intercorrelations, and another factor which was specific to each part. He then was committing no inconsistency when he added the scores on his various parts to get one index. On the other hand, there have been people who claimed that there was no factor common to all of the parts, but yet these same people did not hesitate to add the various scores together to get one index, which was spoken of as a 'thing.' Scores ought not be added unless they are fundamentally measures of the same 'thing.'

If two measures are correlated with each other, then to some extent at least, they are both measuring the same 'thing.' This fact has frequently been overlooked. People have had tests with two different names, have found they were correlated, and have not recognized that to a certain extent both tests were doing the same thing. If there are more than two tests and all are intercorrelated, one can make this same statement about any combination of two. The question of 'mental structure' is how much of that which is common to any two is common to all of the tests. Spearman has claimed that in most situations these intercorrelations are caused by one factor, and the book is written in support of this theory. He has called this factor *g*.

The book will cause a great deal of discussion both favorable and adverse, and if one judges it not at all by the accuracy or falsity of its theory but

*The Abilities of Man: Their Nature and Measurement, by C. Spearman, Grote Professor of Philosophy of Mind at the University of London. vi+415+xxxiii pp., price $4.50. The Macmillan Company, New York, 1927.

only by the discussion, research, and examination of practises which it will cause, one will be compelled to say that it is a very important book.

In fact, the battle over the book is well under way. In an unsigned review*, the book was criticized for having a faulty mathematical basis, incorrect arithmetic, and erroneous deductions. This review led to correspondence† between Spearman and The Reviewer, in which each side promised to bring forth further evidence. These same general objections and criticisms are embodied in a recent article‡ by Pearson and Moul.

In a review§ which treated the appendix, the mathematical portion, very thoroughly, Wilson came to the conclusion that the *g* is "relative to the set up of the tests" (p. 247). Brigham gave a general review** from the point of view of the person engaged in testing. Although pointing out the importance of the book for all who are interested in the logical bases of tests, his general point of criticism was that different *g's* would be obtained under different situations.

One weakness in the determination of the correlation of a test with *g* is the dependence of this correlation upon the range of people being tested. An illustration of this follows. Assume that we have a number of tests of the form

$$x_a = i_a g + s_a \qquad (1)$$

where the *x* is the score on the test, the *i* is a coefficient differing for each test; *g* is the amount of the individual's ability in the common or general factor, and *s* is the amount of an individual's ability in the specific factor. Then the tetrad differences will be zero. Next let there be calculated the correlation of each of the tests with *g;* the general expression for such correlations will be:

$$r_{x_a} = \frac{i_a \sigma_g}{\sigma_{x_a}} \qquad (2)$$

(The numerical value of r_{x_a} is calculated from the formula

$$r^2_{x_a g} = \frac{r_{x_a x_b} r_{x_a x_c}}{r_{x_b x_c}}\Bigg)$$

The correlation between any two tests, a and b, may be expressed as

$$r_{x_a x_b} = \left(\frac{i_a \sigma_g}{\sigma_{x_a}}\right)\left(\frac{i_b \sigma_g}{\sigma_{x_b}}\right) \qquad (3)$$

or as the product of two such terms as (2). Everyone knows that the left hand term of (3) is correlated with the variability of the people upon whom this correlation is calculated. The only way that the left hand term of (3) can increase is to have at least one of the right hand terms increase. This means that $r_{x_a g}$ varies with the variability of the people being tested or in other words that $i_a \sigma_g$ is not a constant proportion of σ_{x_a} for different values of σ_{x_a}. This is unfortunate as there is a tendency to think of this $r_{x_a g}$ as a descriptive fact of the test and not as a descriptive fact of the test in relation to the variability of the group to which the test was applied. It would be advantageous for this work to have a measure of relationship which carried all the advantages of the correlation coefficient and was still independent of the variability of the group under consideration.

A second general weakness in the theory of *g* is the lack of a definition of what constitutes "overlap." The

*The Mathematic of Intelligence. *Nature*, 1927, 120, 181-183.

†The Mathematics of Intelligence. Prof. C. Spearman; The Reviewer. *Nature*, 1927, 120, 690-692.

‡The Mathematics of Intelligence, I. The Sampling Errors in the Theory of Generalized Factor. Karl Pearson and Margaret Moul. *Biometrika*, 1927, 19, 246-291.

§The Abilities of Man, Their Nature and Measurement. C. Spearman. 9 Review by Edwin B. Wilson. *Science*, 1928, 67, 244-248.

**The Personnel Journal*, 1927, 6, 303-306.

usual statement has been that the tetrads will be zero if there is no spurious overlap, but apparently one does not know whether or not one is going to have "overlap" until the tests have been given and the tetrads calculated.

The author has covered the field of tests quite thoroughly and has included descriptions and discussions of them throughout the book. The psychologists who are using tests will doubtless find much of interest here, particularly as these discussions are ordinarily from the point of view of the test's saturation with *g*. If one follows Spearman and if one is interested in measuring *g*, then one wants to use those tests that are the more heavily saturated with *g*. The general result seems to be that the amount of an individual's *g* is estimated better by those operations which are concerned mainly with the eduction of new facts than by those operations which are concerned mainly with the reproduction of known facts. These last operations are improved if they are concerned with the reproduction of facts which were earlier educed.

The geneticist will probably be most interested in the chapter "Heredity and Sex." In this chapter, the author discusses: (a) difference of race; (b) difference of family; (c) difference of environment; and (d) difference of sex. The dearth of real evidence upon these question is recognized. His general conclusion might be stated to be that the differences between the groups are probably less than the differences between the individuals within a group. An interesting point here is the author's calling attention to the fact that if the obtained sibling correlations for mental and physical traits are equal, then probably the true correlations for mental traits are higher than the true correlations for physical traits because mental traits are measured much more inaccurately than physical. As regards the influence of age upon *g*, he concludes that "*g* increases from birth—at first rapidly, then more and more slowly—until somewhere not later than 15-16 years (and perhaps much earlier) its growth definitely ceases. Thereafter, it normally retains this maximum level unaltered right up to the end of life (or, at least, to the onset of senility). The lines for different individuals run parallel to each other; that is to say, whoever is ahead of another at some early age (11 years, or perhaps still younger) will normally retain this advantage for the rest of his days." (p. 375).

It is too bad that the author did not append a bibliography of the literature upon the divisibility of test scores into factors.

Serebrovsky and Petrov's Article Not a Translation

The announcement of "Close Autosomal Linkage in the Fowl" in the July JOURNAL (P. 305) was not translated as stated in the footnote. A series of abstracts from Miss Glessing's translation of the memoirs of the Anikowo Station will be published in the JOURNAL, and through an editorial blunder this paper was taken to be one of the series. The paper on autosomal linkage was submitted in English.

THE INHERITANCE OF ANTHRACNOSE RESISTANCE

In Certain Raspberry Hybrids

A. S. COLBY

University of Illinois

ANTHRACNOSE has become a limiting factor in raspberry growing, especially with the black varieties, throughout much of the territory naturally adapted to their culture. This disease has stopped entirely the growing of raspberries in some sections, while in others the growers secure but two crops before they find it necessary to renew their plantings. Since the fungus does not commonly injure the fruit itself, but causes loss indirectly through weakening the plant, few growers realize the extent of the damage done by this disease, until a season occurs when weather conditions are so favorable for its spread that the fruit dries up and the canes die. The effective control of anthracnose should result in a much greater acreage of raspberries.

The black raspberry varieties most commonly grown in the middle west are Cumberland, Plum Farmer, Black Pearl and Honeysweet. Others less commonly planted are Munger, Gregg, Earhart, Older, and Conrath. All these varieties are fairly susceptible as grown in the test plots at this station. During the last two years the indirect effect of the disease has been very noticeable in less vigorous and less productive plants.

Anthracnose may be controlled in one of two ways; by two seasonal applications of lime sulfur, and by the selection of a partially resistant variety, such as the Quillen[2, 3]. The greater resistance of the Quillen is noticeable upon even casual observation by comparing the variety with others growing beside it.

While with most varieties, commercial control can be obtained by spraying, there has been some doubt as to whether the profits were sufficiently increased in all cases to make it advisable to attempt control in this manner[1]. However, the advantage gained by planting the most resistant varieties will be appreciated by black raspberry growers generally.

Breeding for Disease Resistance

The object in view was two-fold; first, to originate varieties better adapted to Illinois, and second, to study the inheritance of characters. The material available consisted of numerous varieties of the red, black and purple raspberries in the Station test plots. In so far as possible varieties of commercial importance were chosen as parents. The crosses and self-pollinations were made in the field. During the breeding operations the flowers were covered with white cheese-cloth bags.

Approximately 1200 seedlings from the breeding work of 1922 and 1923 have been fruited. There are striking differences in the size and quality and amount of fruit borne on individual plants. Since anthracnose resistance seemed to have such a marked influence on the general health and productivity of the plants, studies were made in 1926 and 1927 on anthracnose resistance of the parent plants as well as the seedlings in the different progenies. The present variety plantation from which the anthracnose resistance records were taken was newly set with young plants, soon after the seedlings

were planted. There is, therefore, very little difference in the age of the plants of the parents and seedlings under test.

A summary of the data obtained is presented in Table I.

Weather conditions during these two seasons have been especially favorable for the spread of anthracnose. It is believed, therefore, that on this account, together with the fact that no attempt was made to control anthracnose by spraying, the resistance of the plants was given a fair test. Other cultural operations, such as cultivation and pruning, were given careful attention. In other words, the plants were subjected to conditions favorable to the disease, but otherwise optimum to growth and fruiting.

In recording the comparative resistance of the different varieties and their seedlings to anthracnose, the individual plants were carefully examined twice each season; first in June, and again in October. Plants in which no diseased canes were found at either of the two inspection periods were classed as free from anthracnose. other plants were classed as having slight, medium, or heavy infection, depending upon whether there were very few, an appreciable number, or very many anthracnose lesions found on the most heavily infected canes in each individual plant stool. Figure 17 illustrates representative canes in these groupings. Many canes of the plants classed in the heavily infected group were almost covered with the irregular blotches, often encircling the cane, so characteristic of the disease. At the second inspection, with the further growth of the canes, longitudinal cracks were frequently observed in the disease lesions. Few of the plants in this group were sufficiently vigorous in 1927 to produce new canes for fruiting the next season. The cumulative effect of the disease will probably prove fatal to many of the plants by 1928.

Results

From a study of the table it will be seen that when the varieties were selfed, some of the seedlings of the F_1 were more resistant to anthracnose than were the parents. It is especially noticeable that Quillen, the only black variety found with any plants entirely free from the disease, is surpassed by 30 per cent of its seedlings in that respect. (See Fig. 18).

A number of promising individuals have been found in each progeny which combine to a high degree their resistance to anthracnose with other good qualities such as size, quality and yield. The percentage of such seedlings varies from 9 per cent with the Royal to 80 per cent with Quillen. Other seedlings which are promising except for anthracnose resistance, may be of value in sections where this disease is not a limiting factor in raspberry production.

Darrow[4] states that he has not been successful in using the red raspberry as the pistillate parent in making crosses between the black and red respberries. Wellington[8] makes no reference to securing red by black crosses in reporting some of the raspberry breeding work at the New York Experiment Station. However, Darrow[4] reports that "Mr. Harlow Rockhill of Iowa, a well-known small fruit breeder, has reported opposite results —crosses of the red by the black raspberry." It is interesting to note, therefore, that crosses both ways have been successfully made in this study (See Table I).

It should be observed that there is a considerable difference in anthracnose susceptibility in the seedlings in the reciprocal crosses. When Plum Farmer is used as the pistillate parent, resistance to anthracnose appears in many more of the seedlings than when it is used as the pollen parent. Of these two parents, while the June is not entirely resistant, it is not so susceptible as Plum Farmer.

The above results show considerable

VARIATION IN SUSCEPTIBILITY

Figure 17

Black raspberry canes showing differences in anthracnose infection. Reading from left to right, Cumberland with heavy infection; Plum Farmer x Cumberland with medium infection; Honey-sweet x Plum Farmer with light infection; Quillen, free from infection.

SUSCEPTIBLE AND RESISTANT VARIETIES

Figure 18

Left: A fruiting branch of the Cumberland black raspberry, beginning to show effects of anthracnose infection on branch, leaf stems, leaves, and fruit pedicels. With sufficient soil moisture the first picking may be good, but the disease will have progressed sufficiently by that time to cause the leaves to drop and the fruit pedicels will be so weakened that the remainder of the fruits will dry up.

Right: A fruiting branch from a seedling of Plum Farmer selfed. The branch and leaves are vigorous and healthy with only an occasional anthracnose lesion. These fruits will ripen normally and be of excellent quality. Resistance to anthracnose in this seedling is much higher than that of its parent.

diversity between varieties and seedlings with respect to anthracnose resistance under conditions which for the different plants under consideration may be regarded as quite closely comparable. In instances of this kind, consideration must be given to all factors which affect anthracnose resistance. While it may be impossible to draw the line sharply between them, nevertheless it is important to know something of the range or influence of each.

Where disease resistance has been studied in other forms, a number of factors have been found to be operative. Klotz[7] working with resistance of sour orange and the susceptibility of lemon to certain bark diseases, found that the trunk bark of sour orange had a much greater inhibitory or paralyzing influence on the action of certain enzyms found in the dried mycelial powder of the causal fungi than did the trunk bark of lemon. He suggests "that resistance to the invasion of the pathogens may be due to the inhibition of one or more of the enzyms of the fungi by some cellular product of the host, and that a sufficient decrease in this paralyzing power might permit the hyphae to progress rapidly, as they do in the bark of the susceptible lemon, and successfully parasitize the host." Some such inhibiting action may be present in the plant tissues of the more resistant raspberry varieties under test at this station.

Jones[6] in working with cabbage found that resistance to yellows appeared in seedlings which also had other desirable commercial characters.

In studying the performance records of the raspberry seedlings it was found that anthracnose resistance was often found combined with such desirable plant characters as quality, season, size of fruit and yield. This indicates independent segregation of these characters which is of great importance in practical breeding.

Dorsey and Bushnell[5] in breeding investigations with the plum, where temperature endurance rather than disease resistance was a limiting factor, report that different individuals under comparable conditions react in a markedly different manner to weather conditions. They state that "it appears that differences in individual response . . . were a result for the most part of their genetic constitution."

The difference in anthracnose resistance found in the raspberry varieties and seedlings reported upon here is believed to be evidence of physiological individuality of the several plants. Whatever the fundamental nature of this difference, the data show that it is inherited to a greater or less degree, so that in a given progeny some plants are killed out while others survive to bear profitable crops.

The range in susceptibility, therefore, suggests that anthracnose resistance is determined by more than a single genetic factor.

The results from this experiment illustrate the effectiveness of breeding and selection as a means of working toward commercial anthracnose resistance in the raspberry, as shown in Table I. While the number of plants in some of the progeny is small, yet the trend of these data would not be expected to change materially with larger numbers.

Literaure Cited

1. Burkholder, W. H. The Anthracnose Disease of the Raspberry and Related Plants. *Cornell Univ. Agr. Exp. Sta. Bul.* 395, p. 181, 1917.

2. Colby, A. S. Anthracnose Resistant Black Raspberry of Promise. *Am. Fruit Grower Mag.*, 46: 3, p. 50, 1925.

3. ————. Further Tests Made of Raspberry Anthracnose. *Ill. Agr. Exp. Sta. Ann. Rept.*, p. 158, 1926.

4. Darrow, G. M. Raspberry Breeding Experiments. *Jour. Heredity*, 17: 9. p. 339-348, 1926.

5. Dorsey, M. J., and J. Bushnell. Plum Investigations, II. The Inheritance of Hardiness. *Minn. Agr. Exp. Sta. Tech. Bul.* 32, p. 28, 1925.

6. Jones, L. R., et al. Fusarium Resistant Cabbage. *Wisc. Agr. Exp. Sta. Res. Bul.* 48, p. 25, 1920.

7. Klotz, L. J. Inhibition of Enzymatic Action as a Possible Factor in the Resistance of Plants to Disease. *Science.* LXVI: 1721, p. 631-632, December 23, 1927.

8. Wellington, R. Raspberry Breeding. *Proc. Amer. Soc. Hort. Sci.*, p. 158, 1913.

TABLE I—Two Years' Tests of Anthracnose Resistance of Raspberries—Parents and Seedlings

Variety	Total No. of Plants	Plants free from infection		Plants with slight infection		Plants with medium infection		Plants with heavy infection	
		No.	Percent	No.	Percent	No.	Percent	No.	Percent
Quillen	218	49	22	141	65	28	13	0	0
Quillen (Selfed)	23	12	52	10	44	1	4	0	0
Cumberland	12	0	0	0	0	0	0	12	100
Cumberland (Selfed)	22	0	0	1	5	3	14	18	81
Cumberland (Open pollinated)	23	0	0	0	0	1	4	22	96
Black Pearl	17	0	0	0	0	2	12	15	88
Black Pearl (Selfed)	127	0	0	7	5	35	28	85	67
Plum Farmer	16	0	0	0	0	5	31	11	69
Plum Farmer (Selfed)	128	0	0	23	18	38	30	67	52
Honey Sweet	15	0	0	0	0	0	0	15	100
Honey Sweet (Selfed)	99	0	0	1	1	14	14	84	85
Older	11	0	0	0	0	0	0	11	100
Older (Selfed)	155	0	0	0	0	9	6	146	94
Royal Purple	159	0	0	96	60	57	36	6	4
Royal Purple (Selfed)	110	0	0	72	65	37	34	1	1
Munger	16	0	0	11	69	5	31	0	0
Munger (Selfed)	45	0	0	20	44	22	49	3	7
Gregg	30	0	0	5	17	8	26	17	57
Gregg (Selfed)	43	0	0	4	9	10	23	29	67
Earhart	19	0	0	6	32	6	31	7	37
Earhart (Selfed)	83	0	0	0	0	16	19	67	80
Conrath	16	0	0	0	0	2	12	14	88
Conrath (Selfed)	164	0	0	3	2	8	5	153	93
June	63	19	30	33	52	11	18	0	0
June x Plum Farmer	24	0	0	0	0	0	0	24	100
Plum Farmer x June	19	0	0	3	16	5	26	11	58
Totals	1657	80	5	436	26	323	19	818	50

A Livestock Encyclopedia

Black's Veterinary Cyclopedia. Edited by William C. Miller. Pp. vii, 1082. Price $6.00. MacMillan & Co., New York. A. & C. Black, London, 1928.

On the same general plan *Black's Medical Dictionary*, this newly published work is designed as a guide to all who have to do with the domestic animals. To one who has always found the reading of encyclopedias a fascinating pastime this volume appeals strongly, such a variety of interesting phenomena being discussed wtih the delightful randomness that alphabetic arrangement assures. As is to be expected, the book is stronger on the side of physiology and disease than on that of genetics and breeding. The ontogeny of the anmial is traced with minute detail from "fertilization" to "disposal of the carcass," but it is odd that such terms as "inbreeding," "mendelism" and "prepotence" are not cross-referenced to F. A. E. Crew's commendable attempt to cram the essentials of genetics into fifteen pages. In addition to 325 text figures, there is a series of excellent full-page half-tone illustrations of the breeds of horses, cattle, and sheep.

R. C. C.